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OUR RECENT DEBTS TO VIVISECTION.*

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LADIES: It is my happy privilege to congratulate you on the completion of your three years of preliminary study, and on your merited reward in receiving the degree of Doctor of Medicine from the oldest and largest medical college for women in the world.

By this degree you are permitted to enter the ranks of one of the most ancient, honorable, and laborious professions. With it you assume certain valued privileges, and have cast upon you certain weighty duties. Both the privileges and the duties will exact from you all the intelligence, skill, tact, and faithfulness which you possess.

You will observe that I said a moment since you had finished your "preliminary" studies; for your first and most pressing duty after graduation, and one for which happily you will at first have ample time, is to continue your medical studies. I do not say complete them, for, be your lives even prolonged far past the allotted threescore and ten, instant, constant, intense study is the imperative condition of the right kind of success. You know very little now. Happy both you and your patients, if even with gray hairs comes ever-growing knowledge.

But you have other duties than those to self—you have great duties to the communities in which you will live. Women especially will not only look to you in times of peril, whether in childbirth or sickness or accident, but also for guidance in that greatest duty and privilege—the prevention rather than the cure of disease. This is the glory of our times and the magnificent duty of our profession, that by enlightened

* The Address to the graduates of the Woman's Medical College of Pennsylvania, Philadelphia, delivered March 11, 1885.

care and wise instruction we can prevent much of the sickness and sorrow of the race, and bid back the Angel of Death.

Hygiene—well named after Hygeia, the goddess of good health—must be one of your principal future studies, and its lessons ever on your lips; line upon line, precept upon precept, here a little, and there a great deal. The greatest need of our College to-day is a Professorship of Hygiene. Would that in this vast audience some one could be found who would endow such a chair in the Woman's Medical College of Pennsylvania!

You must also direct public opinion, and especially the opinion of your own sex, in reference to medical questions; for your information and studies will fit you to be their instructors in all such technical questions.

It is to one of these medical issues of the day that I purpose to direct your attention at present—one as to which intense feeling, especially among women, has been aroused—viz., the question of experiments upon animals.

Epithets and invective have been freely used, but, as befits the audience and the occasion, I shall endeavor to approach it in a perfectly calm and fair spirit, seeking to lay before you only one aspect of a many-sided question, viz., the actual practical benefits it has conferred upon man and animals—a fact that is constantly denied, but which medical evidence proves to be incontestable.

I shall not consider the important older discoveries it has given us, but only those since 1850, almost all of which are within my own personal recollection. Even of these I must omit nearly all of its contributions to physiology and to pathology, though so much of our practice is based upon these, and confine myself to the advances it has enabled us to make in medical and surgical practice. I shall endeavor to state its claims with moderation, for an extravagant claim always produces a revulsion against the claimant, and is as unwise as it is unscientific.

Again, it must be borne in mind that, as in nearly every other advance in civilization and in society, so in medicine, causes are rarely single, but generally multiple and interwoven. While vivisection has been a most potent factor in medical progress, it is only one of several factors the disentanglement of which and the *exact* balancing of how much is due to this or to that are often difficult and sometimes impossible. Let me add one word more. All that I may say is purely upon my own responsibility. I commit the opinion of no one else to any view or any statement of fact.

Medicine in the future must either grow worse, stand still, or grow better.

To grow worse, we must forget our present knowledge—happily, an inconceivable idea.

To stand still, we must accept our present knowledge as a finality, complacently pursuing the well-worn paths; neither hoping nor trying for anything better—happily, again, an impossibility.

To grow better, we must try new methods, give new drugs, perform new operations, or perform old ones in new ways; that is to say, we must make experiments. To these experiments there must be a beginning: they must be tried first on some living body, for it is often forgotten that the dead body can only teach manual dexterity. They must then be tried either on an animal or on *you*. Which shall it be? In many cases, of course, which involve little or no risk to life or health, it is perfectly legitimate to test probable improvements on man first, although one of the gravest and most frequent charges made against us doctors is that we are experimenting upon our patients.

But in many cases they involve great risk to life or health. Here they can not, nay, they must not, be tested first upon man. Must we, then, absolutely forego them, no matter how much of promise for life and health and happiness they possess? If not, the only alternative we have is to try them on the lower animals, and we would be most unwise, nay, more, we would be cruel, cruel both to man and to animals, if we refused to pain or even to slay a few animals, that thousands, both of men and of animals, might live.

Who would think it right to put a few drops of the hydrochlorate of cocaine (a year ago almost an unknown drug) into the eye of a man, not knowing what frightful inflammation or even loss of sight might follow? Had one dared to do it, and had the result been disastrous, would not the law have held him guilty and punished him severely, and all of us said Amen? But so did Christison with Calabar bean, and well-nigh lost his own life. So did Toynbee with prussic acid on himself, and was found dead in his laboratory.* Accordingly, Koller,

* I add the following striking extract from a speech in defense of vivisection, on April 4, 1883, by Sir Lyon Playfair, deputy Speaker of the House of Commons—no mean authority. The italics are my own:

"For myself, although formerly a professor of chemistry in the greatest medical school of this country, I am only responsible for the death of two rabbits by poison, and I ask the attention of the House to the case as a strong justification for experiments on animals, *and yet I should have been treated as a criminal under the present act had it then existed.* Sir James Simpson, who introduced chloroform—that great alleviator of animal suffering—was then alive and in constant quest of new anæsthetics. He came to my laboratory one day to see if I had any new substances likely to suit his purpose. I showed him a liquid which had just been discovered by one of my assistants, and Sir James Simpson, who was bold to rashness in experimenting on himself, desired immediately to inhale it in my private room. I refused to give him any of the liquid unless it was first tried upon rabbits. Two rabbits were accordingly made to inhale it; they quickly passed into anæsthesia and apparently as quickly recovered, but from an after-action of the poison they both died a few hours afterward. *Now, was not this a justifiable experiment upon animals? Was not the sacrifice of two rabbits worth saving the life of the most distinguished physician of his time?* . . . Would that an experiment of a like

of Vienna, properly and wisely tried cocaine first on animals,* and then, finding its beneficial effects, tried it upon man with like results, and one of the most remarkable drugs of modern times was thus made available. We are only on the threshold of its usefulness. It has been used in the eye, the ear, the nose, the mouth, the larynx and all other mucous membranes, in the removal of tumors, and as an internal medicine. When its physiological action has been still more thoroughly and systematically investigated, its poisonous dose ascertained, when we know how it works, what its effects are upon the blood-pressure, the heart, the nerves, the blood-vessels—effects that can not be accurately studied upon man—its usefulness may be increased to an extent as yet but little dreamed of. Should it only soothe the last painful hours of our great hero, General Grant, a nation will bless it and the experiments which gave it effect. Moreover, had the experiments of Dr. Isaac Ott, of Easton, † on this very drug, borne their due fruit, America would have had the honor and the human race the benefits of cocaine ten years ago—ten years of needless suffering!

This is but one illustration of the value of experiments upon animals in the realm of new drugs. In fact, substitute for cocaine other drugs, or new operations, or new methods of medical treatment, and the argument repeats itself for each. Within the last thirty years a multitude of new drugs have thus been discovered, and their effects have been either first tested upon animals, or their properties studied exhaustively in a manner impracticable upon man. I will only enumerate some of them, since time will not allow me to enter upon each in detail. Thus have been introduced lily-of-the-valley in heart-disease, yellow jasmine, in diseases of the heart and nervous system, paraldehyde and chloral-hydrate, so valuable for sleep, caffeine for headache, eucalyptus as an antiseptic and in medicine, nitro-glycerine for nervous maladies, Calabar bean for diseases of the eye and nervous system, naphthaline and iodoform in surgery, quebracho as an antispasmodic, antipyrin and kairin in fever, jaborandi in dropsy, salicylic acid in rheumatism, nitrite of amyl in epilepsy and intermittent fever, jequir-

kind on a rabbit or a Guinea-pig had been used by John Hunter, who probably shortened his own noble life by experimenting on himself! . . .

"Let me give one other instance. . . . A few years ago two young German chemists were assistants in a London laboratory. They were experimenting upon a poison which I will not even name, for its properties are so terrible. It is postponed in its action, and then produces idiocy or death. A experiment on a mouse or a rabbit would have taught them the danger of this frightful poison; but, in ignorance of its subtle properties, they became its unhappy victims, for one died and the other suffered intellectual death. Yet the promoters of this bill would not suffer us to make any experiments on the lower animals *so as to protect man* from such catastrophes. It is by experiments on animals that medicine has learned the benefits, but also has been taught to avoid the dangers of many potent drugs—as chloroform, chloral, and morphia."

* "Archives of Ophthalmology," September and December, 1884, p. 402, New York, Putnams.

† Ott, "Cocaïn, Veratrin, and Gelsemium," Philadelphia, 1874.

ity in ophthalmic surgery, piscidia as a substitute for opium, the hypodermic method of using drugs, and so on through a long list. And, as to the old drugs, it may be truly said that we have little exact, that is scientific, knowledge of any one except through experiments upon animals.*

Let us see now something of what America has done in advancing practical medicine by vivisection. In passing, I may say that the assertion that America has contributed but little, so far from being an argument for the restriction of vivisection, is a strong argument for its further cultivation, in order that greater good may result from remarkable discoveries here, equal to those that I shall show have been made in Europe.

Wounds of the abdomen, especially gunshot-wounds, are among the most fatal injuries known to surgery. A small, innocent-looking, external pistol-wound may cover multiple and almost inevitably fatal perforations of the abdominal contents. The recoveries from 3,717 such wounds during the late civil war only numbered 444, and of those with escape of the intestinal contents the recoveries, says Otis, may be counted on one's fingers. The prevailing treatment as laid down in our text-books has been purely conservative, treating symptoms as they arise. The brilliant results achieved in other abdominal operations have led a few bold spirits, such as our own Sims, Gross, Otis, McGuire, and others, to advocate the opening of the abdomen and the repair of the injuries found.

In May of last year, Parkes, of Chicago, reported to the American Medical Association † a series of systematic experiments on thirty-seven dogs, that were etherized, then shot, the abdomen opened, and the wounds of the intestines, arteries, mesentery, etc., treated by appropriate surgical methods. The results confirmed the belief awakened by earlier experiments and observations that surgery could grapple successfully with multiple and formidable wounds, by sewing them up in various ways, or even by removing a piece of the bowel and uniting the cut ends. Hard upon the heels of this important paper,

* For three hundred years digitalis, for instance, has been given as a *depressant* of the heart, and, when a student, I was taught to avoid it carefully when the heart was weak. But the accurate experiments of Bernard and others have shown that it is, on the contrary, actually a *heart tonic and stimulant.* So long as I live I shall never forget the intense joy of myself and the agonized parents, when one bright young life was brought back from the very grave, some five years ago, by the knowledge of this fact, and this is but one of many such cases. Thus have the action and dangers of our common anæsthetics been positively and accurately ascertained; thus the action of ergot on the blood-vessels, explaining alike its danger as an article of food and its wonderful use in certain tumors of the uterus and diseases of the nervous centers; thus, too, every one who gives opium in its various forms is a debtor to Bernard, and every one who gives strychnine a disciple of Magendie.

† "Medical News," May 17, 1884. I shall refer readers frequently to this journal, as it is often more accessible than foreign journals, and it will refer them to the original papers.

and largely as its result, comes a striking improvement in practice. And remember, that this is only the first fruit of a rich harvest for future time, in all countries, in peace and in war.

November 2d, of last year, a man was brought to the Chambers Street Hospital, in New York, with a pistol-shot wound in the abdomen. Under careful antiseptic precautions, and following the indications of Parkes, the abdomen was opened by Dr. Bull,* coil after coil of the intestines was drawn out, the bullet was found and removed, and seven wounds of the intestines were successively discovered and properly treated, and the patient made an uninterrupted recovery. A recovery, after so many wounds, any one of which would necessarily have been fatal under the old methods of treatment, shows that we have now entered upon a proper and successful method of treatment for such frightful accidents.

This is but one of the remarkable achievements of late years in abdominal surgery. The spleen has been removed, part of the stomach has been cut out for cancer, part of the bladder has been dissected away, the entire gall-bladder has been removed, and several inches of the intestine have been cut out, all with the most remarkable success. To all of these, experiments upon animals have either led the way, or have taught us better methods. To recite each in detail would occupy too much time, but one illustration I must not omit, for the improvement, produced by it and other experiments, affects every abdominal operation. When I was a student, the peritonæum was avoided by knife and needle wherever possible. After the death of his fourth case of ovariotomy, Mr. (now Sir Spencer) Wells, † in making the *post-mortem*, was led to believe that the then received treatment of the peritonæum was incorrect, and that he ought to bring its surfaces in contact in order to obtain secure union. Accordingly, instead of testing his ideas upon women, he experimented upon a few dogs, and found that his suspicions were correct. Since then it has been accepted as a cardinal point in all abdominal operations. Following this came improvements in the ligatures used, in the method of treating the pedicle, in the use of antiseptics, etc., all more or less the result of experiments upon animals, and what are the results? Taking successive hundreds of cases, Sir Spencer Wells's percentage of mortality has decreased steadily from thirty-four per cent to eleven per cent. In 1,000 operations he has saved 769 women from the grave and added a net gain of 17,880 years to human life, to say nothing of the happiness of the thousands related to them by ties of friendship and of blood—a proud boast indeed!

Since then, others have reduced the percentage of deaths after ovariotomy to three in the hundred; and Martin, of Berlin, has lost but one patient from blood-poisoning in his last 130 cases.

* "Medical News," February 14, 1885.

† Wells, "Ovarian and Uterine Tumors," 1882, p. 197.

It can not be claimed, of course, as to *all* this wonderful history of abdominal surgery—and remember that in 1862, when I was a medical student, I heard ovariotomists denounced from a professor's chair as murderers!—that experiments upon animals have done the whole work. No one man, no one series of experiments has sufficed, and experiment *alone* would not have done it. But had such experiments not been made on animals, as to the peritonæum, the pedicle, the sutures, the ligatures, etc., we should be far behind where we now are, and still be ignorantly sacrificing human life and causing human suffering.

But to return to America. The first condition to successful treatment is an accurate knowledge of what any disease is—its cause and its course—then we may guide it, and in due time, it may be, cure it.

Before Dr. H. C. Wood's* accurate experiments on the effects of heat on animals, the nature and effects of sunstroke were almost matters of mere conjecture. Every one had his own theory, and the treatment was equally varied. Even the heat-effects of fever itself—the commonest of all symptoms of disease—were ill understood. Wood exposed animals to temperatures of 120° to 130° Fahr. and studied the effects. These experiments have often been alluded to as "baking animals alive." You will note that the heat was no greater than that to which laborers are frequently exposed in our hot summer-days, when working in the sun or in many industrial works. His experiments showed that the effects of sunstroke—or, as he happily termed it, Thermic or heat fever, a scientific name now widely adopted—were solely due to the heat, death following from coagulation of the muscular structure of the heart, or by its effects on the brain. They explained also many of the phenomena of ordinary fever as the result of heat alone. They have established the rational and now generally-adopted treatment of sunstroke by reduction of the body-temperature; and the same method is now beginning to be appreciated and employed in ordinary fever.†

The same observer, with Dr. Formad, has made important experiments on the nature of diphtheria, and when we learn, as we probably soon shall, how to deal with the microscopic forms of life which seem to be its cause, it will not be too much to hope that we may be able to cope far more successfully with a disease now desolating so many homes.

In India alone twenty thousand human beings die annually from snake-bite,‡ and as yet no antidote has been discovered. How can we

* Wood, "Thermic Fever or Sunstroke," Philadelphia, 1872.

† Eighteen out of Wood's experiments were on the general effects of heat, as above alluded to. In six others the local effects of heat (135° to 190° Fahr.) on the brain, and in four others the local effects (up to 140° Fahr.) on the nerves were studied, and gave most valuable results, entirely and evidently unattainable on man.

‡ Fayrer, "Thanatophidia of India," p. 32.

search intelligently for an antidote until we know accurately the effects of the poison? This can not be studied on man; we must resort to animals, or else let the holocaust go on. Accordingly, Dr. T. Lauder Brunton began such a series of experiments in London, but was stopped by the stringent anti-vivisection laws there in force. But Drs. Weir Mitchell and Reichert,* in this city, have recently undertaken experiments on cobra and rattlesnake venom, the cobra-poison being furnished, be it observed, by the British Government, whose own laws have prevented investigations for the benefit of its own subjects! The results are as yet only partly made known, but they have been brilliantly successful in showing that there are two poisons in such venom, each of which has been isolated and its effects studied. The first step has been taken—the poison is known. Who will raise a finger to stop progress toward the second—the antidote? Can the sacrifice of a few score of animals each year in such research weigh for a moment against the continuous annual sacrifice of twenty thousand human beings?†

The modern history of anæsthetics is also of interest. To say nothing of ether and chloroform, whose safer use Bert has investigated in France, nor of cocaine, to which I have already alluded, let us see what experiments on animals have shown us as to bromide of ethyl—an anæsthetic lately revived in surgery. Its revival has quickly been followed by its abandonment on account of the frequent sacrifice of human life—that is to say, *experiments on human beings* have proved it to be deadly. Now, Dr. H. C. Wood,‡ soon after its reintroduction, made a study of its effects on animals, and showed its physiological dangers. Had his warnings been heeded, not a few human lives would have been saved.

The ideal anæsthetic, that will abolish pain without abolishing consciousness, and do so without danger, is yet to be found. Cocaine is our nearest approach to it. Now, in all fairness and common sense, would it be real kindness or real cruelty to obstruct the search for such an anæsthetic—a search which will surely be rewarded by success, but which, if not carried on by experiments on animals, must be

* "Medical News," April 28, 1883.

† I am permitted by Rev. R. M. Luther, of this city, to state the following fact in illustration of the practical value of vivisection in snake-bite: When a missionary in Burmah, he and his brother-in-law, Rev. Mr. Vinton (two missionary vivisectionists!), made a number of experiments to discover an antidote to the poison of the "brown viper"—a snake but little less venomous than the cobra. They found a substance which is an antidote in about sixty per cent of the cases if applied at once. Thah Mway, one of their native preachers, when bitten by the brown viper, had some of this antidote with him, and by its use his life was saved when on the verge of death. This one life saved has been the means of leading, it is estimated, two thousand Karens to embrace Christianity. Was not this one life worth all the dogs used in the experiments—to make no mention of the many other lives that will be saved in all the future?

‡ "Philadelphia Medical Times," April 24, 1880.

tried by deadly experiments upon man, or else be hopelessly given up?

In 1869 I was called to see a man suffering to the last degree from an abscess in the loin. I recognized the fact that it arose from the kidney, but I was powerless. All that I could do was to mitigate, and that, alas! but little, his pitiless sufferings till death came to his relief, after nearly a year of untold agony. I have never forgotten his sufferings, nor the sharp pain I felt when I learned, two years later, how I might possibly have saved his life. In the very same year (1869), Simon, of Heidelberg,* had a woman under his care suffering from urinary fistulæ from a healthy kidney — a surgical accident he in vain tried to heal. That she could live with one kidney had the other gradually been disabled by disease was probable, for one such diseased kidney had been already removed three times when mistaken for ovarian disease; and physiologists had often removed one or both kidneys in animals. But no one had removed a healthy kidney, and then studied the effects on the remaining kidney and upon the heart; no one had tested what was the best method of reaching the kidney, whether by the abdomen or the loin, or how to deal with its capsule, or the hæmorrhage, or the surgical after-effects. Of course, Simon could have tried the experiment on his patient, blindly trusting to Providence for the result. But he chose the wiser course. He studied the previous literature, experimented on a number of dogs and watched the points above noted, tried various methods of operating upon the dead body, and, after weighing all the *pros* and *cons*, deliberately cut down upon the kidney of his patient after a carefully formulated plan, not by the abdomen, but through the loin, and saved her life. She died in 1877, after eight years of healthy life, free from her loathsome disorder.

Now, what have been the results of these experiments upon a few dogs? One hundred and ninety-eight times the kidney has been removed, and 105 human lives have been saved; 83 times abscesses in the kidney have been opened, and 66 lives saved; 17 times stones have been removed from the kidney without a single death—or, in all, in the last fifteen years, 298 operations, and 188 human lives saved. Besides this, as an extension of the operation in 17 cases, in which the kidney, having no such attachments as ought to anchor it in place, was floating loosely in the abdomen and a source of severe pain, it has been cut down upon and sewed fast in its proper place; and all of these patients but one recovered.

Looking to the future, when not hundreds but thousands of human beings will enjoy the benefits of these operations, and in increasing percentages of recoveries, are not the sufferings inflicted on these few dogs amply justified as in the highest sense kind and humane?†

* Simon, "Chirurgie der Nieren," 1871, preface.

† Very erroneous views prevail as to the sufferings of animals from experiments upon

Not long since Dr. Ferrier, of London, was prosecuted for the alleged performance of certain experiments on the brains of the lower animals. With Fritsch, Hitzig, Goltz, Yeo, and others, he had destroyed or galvanized certain limited areas of the brain (and it must not be forgotten that the brain is wholly without the sense of pain), and so determined the exact nervous centers for certain limited groups of muscles. As a result of their labors, the brain is now mapped out with reasonable accuracy, so that, given certain hitherto ill-understood or obscure localized symptoms, we can now say that there is certainly a tumor, an abscess, or other disease in precisely this or that locality. True, we can doubtfully infer somewhat of the same from the cruel experiments of disease on man. But Nature's experiments are rarely ever limited in area or uncomplicated; they are never systematic and exhaustive; it takes years to collect a fair number of her clumsy experiments, and the knowledge is diffused through many minds instead of being centered in one that will systematize the results.

Said Ferrier, a year ago, in the Marshall Hall oration, "There are already signs that we are within measurable distance of the successful treatment by surgery of some of the most distressing and otherwise hopeless forms of intra-cranial disease, which will vie with the splendid achievements of abdominal surgery."

Note the fulfillment! Last fall, within a year of the foregoing prophecy, a man, aged twenty-five, entered the London Hospital for Epilepsy and Paralysis.* From the symptoms, which I need not detail, Dr. Hughes Bennett, basing his conclusions on Ferrier's experiments, diagnosticated a tumor of small size on the surface of the brain, involving the center of motion for the muscles of the hand. On November 15, 1884, at his instance, Mr. Godlee trephined the skull over the selected spot, and a quarter of an inch below the surface of the brain found a tumor as big as a walnut, and removed it. For three weeks the man did well, but died on the twenty-eighth day from blood-poisoning, such as might follow any operation, especially a new one. Macewen, of Glasgow,† has similarly trephined a woman, the victim of slow paralysis of body and mind, and opened an abscess a little distance below the surface, letting out two teaspoonfuls of pus, and followed by entire mental and physical recovery.

them. Many persons suppose that "vivisection" means deliberate "cutting up" of an animal, little by little, till not enough is left to live. So far is this from the truth, that Professor Gerald Yeo, from the actual reports of vivisectionists in England ("Fortnightly Review, March, 1882), estimates that of one hundred such experiments, there are:

Absolutely painless	75
As painful as vaccination	20
As painful as the healing of a wound	4
As painful as a surgical operation	1
Total	100

* "Medical News," January 17, 1885. † Ibid., January 3, 1885.

By these experiments and operations a wide door is open to surgery in the treatment of diseases within the skull—diseases heretofore so obscure and uncertain that we have hardly dared to attack them. The question is not whether death or recovery followed in these particular cases. The great, the startling, the encouraging fact is that, thanks to these experiments, we can now, with well-nigh absolute certainty, diagnosticate, and with the greatest accuracy locate such diseases, and therefore reach them by operation, and treat them successfully. Would that I had been born twenty-five years later, that I might enjoy with you the full luxury of such magnificent life-saving, health-giving discoveries!

It is, however, by the experimental study of the effects of minute organisms—microbes, as they are now called—that some of the latest and most remarkable results have been achieved. The labors of Koch, Pasteur, Klein, Cheyne, Tommasi-Crudeli, Wood, Formad, Sternberg, and others, are now known even to the daily press. Let us see what they have done.

It is but three years since Koch announced that consumption was caused by the "bacillus tuberculosis." Later he has studied cholera and found the "comma-bacillus," to which he ascribes that dreaded disease. In spite of the opposition of prominent scientists, his views have been in general accepted, and seem to be reasonable.

The method of experiment is simple, though difficult. The suspected expectoration or discharge is placed in a suitable soil, and after cultivation some of this growth is placed in another culture-soil, and so on till generation after generation is produced, the violence of the poison being modified by each culture. A small portion of any one of these cultures is then injected under the skin of a mouse or other animal, and in time it dies or is killed, and the results are verified by the *post-mortem*.

So exact is the knowledge in tuberculosis now that Koch can predict almost to an hour when the mouse will die of consumption, or that it will escape, according to the culture used.

It is far too early as yet to say that these studies have borne the immense practical fruit that the next few years will show; but they have already enabled us to recognize by the microscope doubtful cases of consumption in their earlier and more remediable stages, and have made certain what has hitherto been only a probability—that consumption is distinctly contagious.

By Gerlach's experiments on animals with the milk from tubercular cows, also, it has been shown that consumption may be contracted from such milk. How important this conclusion is, in so universal an article of food to young and old, I need not do aught than state.

The experiments of Wood and Formad on diphtheria I have already alluded to. Those of Tommasi-Crudeli also have shown that probably

the poison of malaria is due to like organisms, while a large number of other diseases are being similarly investigated.

As to cholera, the classic experiments of Thiersch, in 1853, * are well known. He inoculated fifty-six mice with cholera-discharges. Of these, forty-four sickened and fourteen died from choleraic diseases. In the same year two water companies in London experimented on 500,000 human beings, one of them inoculating its patrons with cholera-discharges through its impure water-supply. This one sickened thousands and killed 3,476 human beings, most of whom might have escaped had the lessons of Thiersch's fourteen mice been heeded. To ask the question, which was the more cruel, is to answer it. †

At present our strenuous efforts are all in one direction—viz., to study these microbes by the microscope, by clinical observation, and by experiments on animals, in order to find out their origin, causes, growth, and effects, and to discover by what means their deadly results may be avoided, or by what remedies, without harm to the patient, they may themselves be destroyed. Evidently these studies can not be tried on our patients. They must either be tried on animals or be abandoned.

The inoculation experiments of modern times have recently borne rich fruit in still another pestilential disease—yellow fever—whose ravages in this country are fresh in our minds. November 10, 1884, M. Bouley reported to the Paris Academy of Sciences ‡ that, since 1880, M. Freire, of Rio Janeiro, had experimented on Guinea-pigs with the virus of yellow fever, and believed that he had been able to produce such attenuation of the virus that by vaccination he could secure immunity from this dreadful scourge. Following the experiments, he and Rabourgeon tested the results on themselves, some students of medicine, and employés. Later the Emperor Dom Pedro authorized two hundred wharf-laborers to be inoculated. All these, after a three days' mild attack, remained free from the pestilence, while their fellow-laborers, similarly exposed to the fever, were dying on every hand. If, in an epidemic, this still prove true, as there seems every probability it will, from the five hundred lives already saved, we can hardly estimate either the medical or the commercial advantages to this coun-

* John Simon, "Proceedings International Medical Congress," London, 1881.

† The population supplied by the Southwark and Vauxhall Company, in the epidemic of 1848–'49, died at the rate of 118 in each 10,000, and, in that of 1853–'54, at the rate of 130 per 10,000. Those supplied by the Lambeth Company died in 1848–'49 at the rate of 125 per 10,000, but having improved its water-supply meantime, the death-rate, in 1853–'54, fell to 37 per 10,000.

If Thiersch lived in England to-day, he would have to take out a license to kill his fourteen mice in the interests of humanity—a license possibly refused, or only to be obtained after the most vexatious delays. But any house-maid might torture and kill them with arsenic or phosphorus, or Thiersch might give them to a favorite terrier without the slightest interference, provided only it be not for a scientific or a humane object!

‡ "Medical News," November 29, 1884.

try alone. Is this cruelty? Let Norfolk, and Memphis, and Pensacola, and New Orleans answer.

We are all familiar now with the numerous deaths from eating pork infested with trichina. While I was in Berlin, in 1865–'66, a terrible epidemic of the then new disease broke out at Hedersleben, a small town in Prussian Saxony. I well remember with what zeal Virchow and his assistants immediately investigated the disease, inoculated animals with the parasitic worm, studied its natural history, found out that heat killed it, and to-day, as a result of these and other experiments, we all know how to avert its dangers by proper cooking, or to avoid it altogether by the microscope. The value of these experiments, both to human life and to commerce, you know even from the daily papers.

You will find it difficult to make the non-medical public understand —nay, you yourselves as yet hardly understand—the enormous advance in medicine and surgery brought about by recent researches on inflammation, and by the use of antiseptics. My own professional life only covers twenty-three years, yet in that time I have seen our knowledge of inflammation wholly changed, and the practice of surgery so revolutionized that what would have been impossible audacity in 1862 has become ordinary practice in 1885.

It would seem that so old a process as inflammation would long ago have been known through and through, and that nothing new could be adduced. In 1851, however, Claude-Bernard, by a slight operation, divided the sympathetic nerve in a rabbit's neck and showed its influence on the caliber of the blood-vessels. In 1858 Virchow published his "Cellular Pathology." In 1867 Cohnheim (Virchow's "Archiv") published his studies on the part that the blood-cells played in inflammation as shown in the frog, followed by further papers by Dr. Norris, of this city, Stricker, Von Recklinghausen, Waldeyer, and many others. Already in my lectures I have pointed out to you in detail the advances made by these studies, both in theory and practice. They have brought about an entire reinvestigation of disease, and given us wholly new knowledge as to abscesses, ulceration, gangrene, the organization of clots in wounds, and after operations and ligature of blood-vessels for aneurism, as to thrombosis, and embolism, and paralysis, and apoplexy, and a score of other diseases through the diagnosis and treatment of which now runs the silver thread of knowledge instead of ignorance.

With this the brilliant results of the antiseptic system have joined to give us a new surgery. Sir Joseph Lister, to whom we chiefly owe this knowledge, has done more to save human life and diminish human suffering than any other man of the last fifty years. Had he only made practicable the use of animal ligatures, it would have been an untold boon, the value of which can only be appreciated by doctors; but he has done far more, he has founded a new system of surgery.

We may reject the spray and carbolic acid, but the surgical world, regardless of details, with few exceptions follows the principles upon which his method is founded and humanity is the gainer, by the nearly total abolition of inflammation, suppuration, secondary hæmorrhage, blood-poisoning, gangrene, and erysipelas, as sequels of accidents and operations; by the practicable relief from suffering and death, by operations formerly impossible; by rendering amputations and compound fractures safe and simple instead of deadly. Reflect on what each one of these brief but momentous statements means!

But we have by no means reached perfection. Lister himself, no tyro, but the great master, is still searching for further improvements. But when lately he desired to make some experiments on animals, still further to perfect our practice, so many obstructions were thrown in his way in England that he was driven to Toulouse to pursue his humane researches.

I had intended also to speak of many other practical benefits to man directly, but can only mention such important matters as the surgery of the thyroid gland, the seat of goitre; the surgery of the lungs, part of which have been removed; the surgery of the nerves, removal of the entire larynx, the remarkable researches of late years as to the periosteum in the reproduction of new bone after removal of dead or diseased bone; Bernard's important observations as to diabetes; Brown-Séquard's experiments on epilepsy, the modern extraordinary advance in nearly all the diseases of the nervous system, and a number of other discoveries, as to all of which experiments upon animals have added largely to our knowledge, and therefore to our means of diminishing suffering and saving human life. For many of these, as well as for the most judicial discussion of the vivisection question I have yet seen, I must refer you to that remarkable book, "Physiological Cruelty," written, not by a man, *but a woman.**

I had also intended to refer in detail to the splendid results of vivisection in relieving the sufferings of animals, and in preventing enormous pecuniary loss to man. We are only beginning to see that vivisection is as humane to animal life and suffering as it is to human, and that for financial reasons as well as humane motives it is of the utmost importance to the State that such diseases as cattle-plague, splenic fever, chicken-cholera, swine-plague, and others, should be eradicated. Vivisection has shown us how this may be done, and has so conferred upon animals too the boon of life and health. For all this, however, I must refer you to the recent admirable lecture by Professor Robert Meade Smith, of the University of Pennsylvania.†

One subject, however, is so recent and of such interest, both to man and animals, that I must not pass it over—I mean that justly-

* See also the just issued "Life and Labors of Pasteur."

† Reprinted from the "Therapeutic Gazette," November, 1884.

dreaded disease hydrophobia. Thanks to vivisection, its abolition in the near future seems no longer to be a matter of doubt.

Within the last three years Pasteur has announced that, by passing the virus through the monkey, he has been able to protect dogs from hydrophobia by vaccination with this weakened virus. The French Government recently appointed an eminent scientific commission to report on the alleged discovery.* Pasteur furnished them with 23 vaccinated dogs. These 23, and 19 others unprotected, were all inoculated from rabid animals. Of the 19 unprotected, 14 died. Of the 23 protected dogs, one died of diarrhœa, and all the others escaped. It has yet to be tried on a man suffering from hydrophobia, but, should our reasonable hopes be realized, what a boon it will be!

With this brief summary of a few of the recent practical benefits from vivisection, I must close. I have given you only ascertained facts for your future use in the communities in which you may settle. They may assist you in forming public sentiment on a basis of fact, of reason, and of common sense. The sentiments of our own profession, so constantly and so conspicuously humane, are always against inflicting pain; but if in yielding to sentiment we actually increase disease, and pain, and death, both among animals and men, our aversion to present pain is both unwise and actually cruel.

In conclusion, let me wish you the greatest success in your professional life, and the richest blessings of our kind heavenly Father. Farewell.

CAN MAN BE MODIFIED BY SELECTION?†

By W. K. BROOKS.

THE certainty and rapidity with which our domesticated animals and plants may be modified in any desired direction by selective breeding must be regarded as a reason for believing that, if it were possible to pursue the same course with man, the human race also might be rapidly improved in the same way. It is difficult to prove this, for we are almost entirely removed, by our control over Nature and by our artificial life, from the influence of natural selection; and, as we can not dictate to men and women whom they shall marry, we can not bring about a union of those with the same congenital characteristics, or propagate for a number of generations a peculiarity which it is desirable to perpetuate and intensify.

There is reason to fear that our freedom from the influence of natural selection may lead to the degeneration of the race unless some

* "Medical News," August 30, 1884.

† Review of a paper by Alexander Graham Bell, read before the National Academy of Sciences, November 13, 1883, upon the "Formation of a Deaf Variety of the Human Race."

way to supply its place is discovered and adopted; and the first step in this direction is to prove by actual experiment that the race can be modified by selection like any other species of organism.

The researches of Professor Bell, which show that a race of deaf-mutes is actually growing up in the United States through an unfortunate application of the law of selection, therefore have a very great scientific value, which is entirely independent of the warning they give of a danger which threatens us.

In the paper which is quoted above he renders the community an important service by pointing out this danger; but it seems to me that the chief value of his work is not in this direct practical bearing, but in the convincing proof which he furnishes to show that the law of selection does place within our reach a powerful influence for the improvement of our race, for, as soon as the truth is borne home to all men by facts like those which Professor Bell has brought together, some effective means of applying it to mankind will certainly be devised.

Mankind will not submit to any direct interference with personal liberty; but, if it is true that desirable characteristics can be perpetuated and developed by selection, indirect methods of influencing the choice of husbands and wives could undoubtedly be devised and employed.

If all the children which exhibit the desired peculiarity could be brought together as early as possible, and could be made to live together during their youth, carefully guarded from the possibility of making acquaintance with any other children, and if this restriction could be continued through the period when acquaintances and friendships and attachments are most easily established, this would be a great step toward selective breeding; for all the children with the desired peculiarity would become intimately acquainted with one another, while they would have few outside friendships. If, after the children had grown up and become scattered, they were encouraged to hold periodical reunions for promoting social intercourse between them in adult life, and if they were provided with newspapers and periodicals of their own, which should make a specialty of "personals" relating to them, giving a full account of their conventions and reunions, and keeping their readers informed of all their movements, their employments, their marriages, deaths, etc., the chances of intermarriage among them would be greatly increased.

If they were taught to speak and think in a language of their own, and were furnished with a literature of their own in this language, they would be very effectively cut off from intercourse with outsiders, and would be compelled to look to their own numbers for their companions and acquaintances; and there can be no doubt that, if all these influences were employed together generation after generation, they would soon lead to the establishment of a race sharply marked off

from the rest of the world by the excessive development of the characteristic upon which the selection was based.

If the selection were a wise one, the result would be to the benefit of mankind; but the result would follow just as surely if an injurious peculiarity or a defect were made the basis of the selection, for a natural law produces its effect, whether it is applied wisely or unwisely.

Professor Bell points out that our system of educating the deaf brings all these influences to bear, and that the means which have been adopted by philanthropists and others from the noblest and purest motives to ameliorate the condition of the deaf and dumb are unfortunately the most complete and efficient methods which it is possible to employ for inducing deaf-mutes to marry deaf-mutes, and that it would be difficult to devise a more certain means for increasing the number of unfortunate persons with this infirmity, and for producing by selection a deaf variety of the human race.

We separate them from other children as early in life as possible, taking them away from their homes and placing them by hundreds in institutions where they are isolated from early childhood to the commencement of adult life. Each deaf person is therefore intimately acquainted with nearly all the others of his own generation, while there are few opportunities for the formation of congenial and lasting intimacies with outsiders. The graduates of the institution organize themselves into societies or conventions for the promotion of social intercourse in adult life, and these societies are to be found in all large cities, in rooms where they meet for social intercourse, and for religious worship. They hold State and national conventions, which are attended by deaf-mutes of both sexes from all parts of the country, and they publish newspapers and periodicals of their own which are filled with personal items.

They are taught a special language which is as different from English as French or German or Russian, and they learn to think in the gesture-language, so that English is apt to remain a foreign tongue, while they often write in broken English as a foreigner would speak, so that they are in a great measure cut off from all of our literature except its very simplest forms, and they have imperfect sources of information upon topics which engage the interest of the rest of the community, such as social and political matters.

Although there is no compulsion or infringement of personal liberty, all these influences combine to induce deaf-mutes to select for their partners in life persons who are familiar with the gesture-language, and with whom they have been thrown from childhood. We have, therefore, adopted most of the means which tend toward the formation of a deaf-mute variety of the human race, and time alone is necessary to accomplish the result; but there are still other means which might be employed to hasten it. Professor Bell says that, with

this end in view, we might attempt to formulate some plan which should lead the deaf children of deaf-mutes to marry one another instead of marrying deaf-mutes who have not inherited their deafness, or to marry hearing persons belonging to families in which deafness is hereditary. If, for instance, a number of the large deaf-mute families of the United States were to settle in a common place so as to form a community largely composed of deaf-mutes, then the deaf children born in the colony would be thrown into association with one another, and would probably marry in adult life or marry hearing persons belonging to deaf-mute families, and each succeeding generation of deaf-mutes would increase the probability of the deaf-mute element being rendered permanent by heredity; and we might anticipate that a very few generations would suffice for the establishment of a permanent race of deaf-mutes with a language and literature of their own.

Plans for the formation of such a community of deaf-mutes have many times been discussed by the deaf-mutes themselves, contributions of money for the purpose have been publicly offered, and it has even been proposed to procure the enactment of laws to secure the descent of the land and other property in the deaf-mute line alone, so that the hearing children would be led to leave the community. A colony of this sort has even been founded in Manitoba, and twenty-four deaf-mutes with their families have already arrived from Europe and have settled upon the land, while more are expected this year.

The analogy of all other organisms would lead us to expect that, with all these selective influences at work, the number of deaf-mutes should increase rapidly, and the interesting question, "How far do the facts justify this opinion?" at once presents itself, and we ask, first, whether deafness is hereditary; and, second, whether it is true that many deaf-mutes marry; and, third, whether our system of education does lead those who marry to select deaf-mutes as their partners; and, fourth, whether deafness is more frequent among their children than it is in the community at large.

If the published records answer all these questions in the affirmative, it is clear that, however much the present system may appeal to our sympathies, it is neither the best one for the interests of the whole community, nor the best for the deaf themselves, since it tends to increase the evil which it is designed to alleviate.

Few of the institutions publish any record regarding the relatives of pupils, but the records of the American Asylum, at Hartford, Connecticut, show that, of 2,106 pupils admitted to that institution, 693, or nearly 33 per cent, were known to have deaf-mute relatives, and in the majority of these cases the pupils have more than one relative deaf and dumb, while in a few cases as many as 15 deaf-mute relatives are recorded. The report of this institution for 1877 shows that

593 pupils had one or more brothers or sisters deaf and dumb.
100 " " cousins "

47 pupils had one or more parents deaf and dumb.
38 " " " uncles or aunts deaf and dumb.
29 " " " children "
48 " " " distant relatives "
5 " " " grandparents "
1 " " " great-grandparent "
1 " " " great-uncle or aunt "

That this is not peculiar to the pupils of this particular institution, and that it holds true of deaf-mutes in general, is shown by the following table, compiled from the records of six institutions :

INSTITUTIONS.	Total number of pupils.	Number of pupils having deaf-mute relatives.	Percentage of pupils having deaf-mute relatives.
American Asylum	2,106	693	32·9
New York Institution	1,165	380	32·6
Ohio Institution	560	166	29·6
Indiana Institution	283	103	36·4
Illinois Institution	1,620	356	21·7
Texas Institution	89	21	23·6
Total	5,823	1,719	29·5

The table shows that, among 5,823 deaf-mutes taken from different parts of the country, 1,719, or 29½ per cent, are known to have had deaf-mute relatives, and that this is due to the influence of heredity is well shown when we contrast those who were born deaf with those who had afterward lost their hearing. Many of those who lose their hearing by accident or disease have no hereditary tendency to deafness, but a considerable number of those who lose their hearing at some time after birth are born with an hereditary predisposition to deafness. If, therefore, we contrast the congenitally deaf with those who have become deaf, we should expect the latter class to have a much smaller percentage of deaf relatives than the former class, but a greater percentage than the community at large.

Professor Bell has compiled the following two tables from the one which is given above, and they show that, while only about 13 per cent of the pupils which were not born deaf have deaf relatives, more than 54 per cent of the congenitally deaf pupils are recorded as having such relatives :

TABLE II.—*Proportion of the Non-congenitally Deaf who have Deaf Relatives.*

INSTITUTIONS.	Number of non-congenital deaf-mutes.	Number having deaf-mute relatives.	Percentage having deaf-mute relatives.
American Asylum	1,040	131	12·6
New York Institution	432	74	17·1
Ohio Institution	268	32	11·9
Indiana Institution	124	31	25·
Illinois Institution	947	120	12·7
Texas Institution	53	8	15·
Total	2,864	396	13·8

TABLE III.—*Proportion of the Congenitally Deaf who have Deaf-Mute Relatives.*

INSTITUTIONS.	Number of congenitally deaf pupils.	Number having deaf-mute relatives.	Percentage having deaf-mute relatives.
American Asylum	973	552	56·7
New York Institution	488	287	58·8
Ohio Institution	208	118	56·7
Indiana Institution	149	72	48·3
Illinois Institution	418	194	46·4
Texas Institution	26	11	42·3
Total	2,262	1,234	54·5

These tables show that, of 2,262 congenital deaf-mutes, more than half are known to have had deaf-mute relatives, and that, even in the case of those pupils who become deaf from apparently accidental causes, more than 13 per cent had other members of their families deaf and dumb.

In answer to the second question, Do deaf-mutes marry? Professor Bell gives a number of tables, one of which shows that, out of 1,259 pupils at the American Asylum and the Illinois Institution who were born before 1840, 571, or nearly half (45·4 per cent), are recorded as married. The records for later years show a much smaller number of marriages in proportion to the total number of pupils; but this would necessarily be the case, because most of them are as yet children.

In order to determine how many of this 45 per cent of deaf persons who marry chose deaf-mutes for their partners, Professor Bell has compiled the following table from the records of five of our largest institutions for the deaf and dumb:

TABLE IV.—*Proportion of the Deaf and Dumb who marry Deaf-Mutes.*

INSTITUTIONS.	Total number of pupils recorded to have married.	Total number recorded to have married deaf-mutes.	Percentage.
American Asylum	642	502	78·2
New York Institution	191	142	74·3
Ohio Institution	56	39	69·6
Indiana Institution	26	21	80·8
Illinois Institution	174	152	87·3
Total	1,089	856	78·6

This shows that nearly 80 per cent of the deaf-mutes who marry at all marry deaf persons; but it does not follow that 80 per cent of the marriages were between deaf persons, for it is probable that nearly all of the 856 pupils who married deaf persons married pupils, so that there may possibly have been only 428 weddings; while the 1,089 *minus* 856, which equals 233 who married hearing persons, may represent only 233 weddings, so that, out of 661 marriages, only 428, or 65

per cent, may have been between deaf persons, but even this is an alarming frequency, if it is true that the children of such unions are predisposed to deafness.

If it is true that our system of educating the deaf is responsible for the number of marriages between deaf persons, we should expect to find these marriages increasing in numbers, and Professor Bell has compiled from the table above quoted the following table, which shows that this is the case :

YEAR OF BIRTH.	Total recorded to have married.	Total recorded to have married deaf-mutes.	Percentage.
Before 1810.....	129	72	55·8
1810 to 1839.....	715	577	80·7
1840 to 1859.....	233	196	84·1
1860 and after	12	11	91·7

These two tables show that the tendency of deaf-mutes to select deaf-mutes as their partners in marriage is very pronounced, and that it is much more developed now than it was during the early half of the century, and that it is steadily increasing.

Thus there is every indication that this process of selection will go on from generation to generation, and that a large proportion of the deaf children of deaf parents will themselves marry, and that, of those who marry, the majority will marry deaf-mutes.

If it is true that deafness is hereditary, this can have only one result—the increase of deafness.

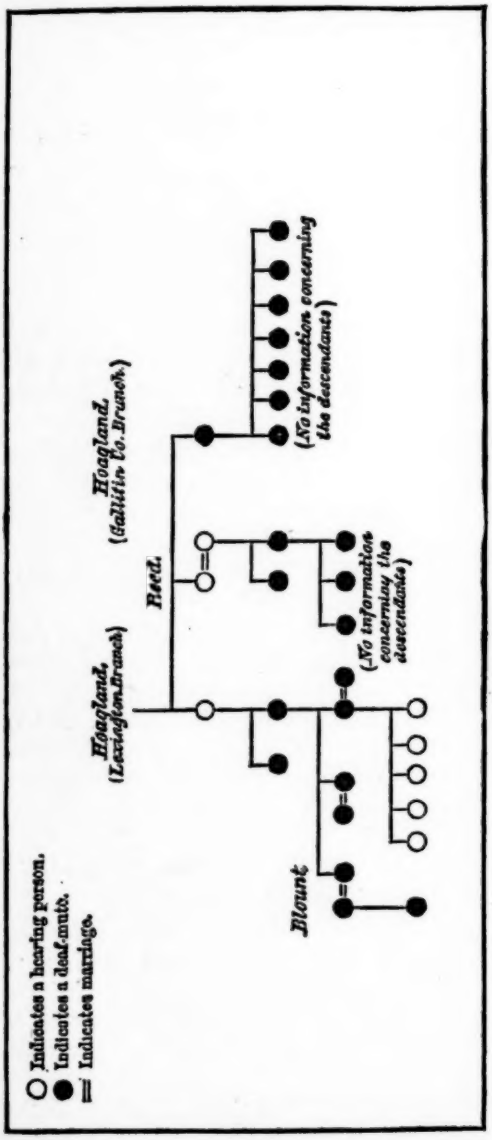
There are very few reliable statistics regarding the number of children born to deaf-mutes, or the proportion of deaf children, but Dr. Turner, formerly the Principal of the American Asylum, stated, in 1868, that statistics carefully collated from records kept of deaf-mutes, as they have met in conventions at Hartford, show that *in eighty-six families, with one parent a congenital deaf-mute, one tenth of the children were deaf; and in twenty-four families, with both parents congenital deaf-mutes, about one third were born deaf.*

In 1854 Dr. Peet, the Principal of the New York Institution, said that, of all the families of which he had records, "*about one in twenty have deaf-mute children where both parents are deaf-mutes, and about one in one hundred and thirty-five where only one is a deaf-mute; and that the brother and sister of a deaf-mute are about as liable to have deaf-mute children as the deaf-mute himself, supposing each to marry into families that have, or each into families that have not, shown a predisposition toward deaf-dumbness.*"

Our author has attempted to trace out from the scanty records the history of certain families in which deafness is hereditary, and he has expressed the facts in a number of graphic diagrams, two of which are here reproduced.

THE HOAGLAND FAMILY, OF KENTUCKY.

In this family nineteen out of twenty-six descendants were deaf, and it is interesting to note that, although one of the members of the family was a hearing person, and married a hearing husband (Reed), their two children and three grandchildren were all deaf. One of the descendants, No. 1, was deaf and married a deaf-mute, but their five children all hear. No one could refer to this branch of the family as a proof that deafness is not hereditary, however.



THE HOAGLAND FAMILY, OF KENTUCKY.

The diagram on the following page shows the genealogy of the Fullerton family, of Hebron, New York:

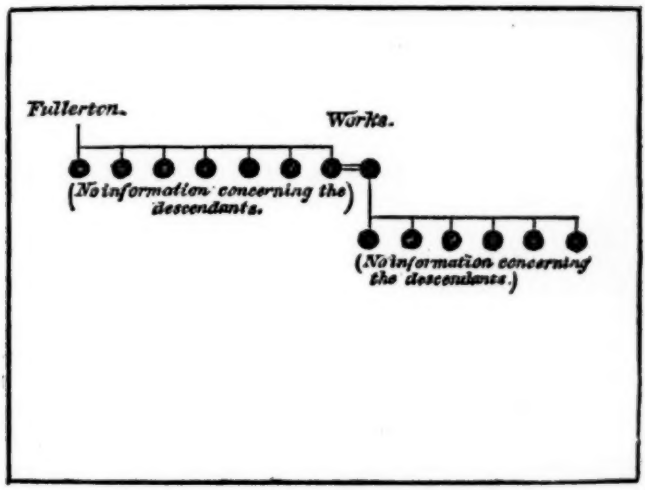
Fullerton had seven children, all deaf and dumb. There is no further information about six of these children or their descendants; but the seventh, Jane Fullerton (1), married Sayles Works (2), who was also a deaf-mute, and all their six children were deaf and dumb. No information was obtained regarding the descendants of these six children.

Those persons who are not familiar with logical reasoning will point to married deaf-mutes with hearing children as proof that such marriages are not to be condemned; but, in order to prove that deafness is hereditary, it is not necessary to show that all the children of deaf parents are deaf, but only that the number of deaf children,

as compared with the hearing children, is greater than it is in the community as a whole, and this fact is proved beyond question by the statistics.

The census returns show that there are 33,878 deaf-mutes in the country, or that one person out of every 1,500 is deaf ; or that, out of each 1,500 children who are born, 1,499 retain their hearing throughout life, while only one is deaf.

If deaf children are no more numerous in the families of deaf parents than they are elsewhere in the community, only 23 out of the 33,878 deaf-mutes should have deaf parents ; but we have a record of nearly ten times this number, for Professor Bell states that, although



THE FULLERTON FAMILY OF HEBRON, NEW YORK.

only thirty-five of the fifty-eight institutions of the country have sent replies to his queries, the returns from these thirty-five show that no less than 207 deaf children of deaf parents have been admitted as pupils. Deaf children are, therefore, at least ten times as numerous in families where the parents are deaf as they are in the community at large, and it is impossible, after reading Professor Bell's paper, to doubt—1. That deafness is hereditary ; 2. That, of the deaf persons who marry, nearly all select deaf partners ; 3. That their children are especially liable to deafness ; and, 4. That the number of deaf-mutes who marry deaf-mutes is increasing, and that our educational system fosters this tendency, and is to a great extent responsible for it.

So far Professor Bell's conclusions seem to be unanswerable, and there is no room to doubt that the means that we have adopted for the amelioration of the conditions of the deaf have actually tended to increase the evil they were intended to diminish.

The question whether this can be avoided, while the system as a whole is retained, is one upon which there may well be a difference of opinion; and the fact that the publication in 1868 of a paper on "Hereditary Deafness," by the Principal of the American Asylum, the Rev. W. W. Turner, has been followed by a decrease in the number of marriages between the pupils of that institution, seems to show that it may be possible to accomplish much by repressive influences. Our author believes, however, that the defect is inherent in our system, and that a complete change is necessary; and that the segregation of deaf children in institutions, where they are kept by themselves, really lies at the root of the matter; and that the grand central principle, which should guide us in our search for preventive measures, should be the retention of the normal environment during the period of education. The direction of change should therefore be toward the establishment of small schools and the extension of the day-school plan. The average cost of the education of a deaf child in an American institution is $223.28 per annum, and a small day-school could be maintained at no greater cost, although the parents would be compelled to furnish, in addition, the industrial training which is now provided by the State; but this would give no concern, for so many deaf-mutes are now earning their livelihood by trades which are not taught in the institutions as to demonstrate the practicability of apprenticing deaf-mutes in ordinary shops.

The employment of the gesture-language and lack of articulate speech are efficient elements operating to separate deaf-mutes from hearing persons, and Professor Bell advises that all deaf pupils should receive instruction in articulation and in speech-reading. In the schools of Europe more than 65 per cent of the deaf and dumb were, in 1882, receiving efficient instruction in this way, and were taught to speak and understand the speech of hearing persons, while in our institutions 4,241 pupils received no instruction whatever in articulation, and only 886, or 14 per cent, were under oral instruction.

The question whether these remedies are the best and most practicable ones or not may safely be left to the judgment of the able men who have devoted their lives to the subject; but all those whose sympathies for this unfortunate class are strongly excited must bear in mind that the interests of the whole community are also to be considered, and no one could, in the interest of humanity, or even in the interest of that small portion of the human race most directly concerned, advocate measures which lead to the perpetuation and increase of the evil.

Whether we approve of Professor Bell's recommendations or not, all persons, those who hear as well as those who do not, must feel that he has done good service to the community by calling attention to the danger which now attends our system, but his paper is far more than a warning: it is a promise, and its direct practical bearing is a very

small part of its value, for the facts which he has brought together prove that man can be modified by selection as readily as any of our domesticated animals or plants, and that increased knowledge will ultimately enable us to bring about rapid improvements in our race.

CHOLERA.

By Dr. MAX VON PETTENKOFER.*

IV.—PREVENTION.

THE last sheet-anchor of the contagionists is always the linen of cholera-patients. But this view rests on such debatable ground that in the end it may prove to be fallacious. If cholera is really spread through human intercourse, then it is clear that the unknown specific something must accompany other vehicles, which may be man himself; and if this something can cause illness in man, then it must reside in the system of the patient, and ought to be found there. There can be no doubt of this; and I am prepared to admit as much. Thirty years ago I began my investigations on cholera in the belief that the germs of cholera were contained in the stools; but afterward, having made sure that cholera was dependent on locality as well as human intercourse, I endeavored to see how this relationship obtained by asking myself what was brought to the soil by man in his journeyings. The reply was, urine and stools—his excrements and nothing else. This view ripened into the belief that disinfection of the excreta and their receptacles ought to be a prophylactic measure against the spread of cholera, and excreta which had not been disinfected constituted a source of danger. These thoughts occupied me up to April, 1866, when I published with my lamented friends, Griesinger and Wunderlich, some regulations on cholera; and I first relinquished these views when further study showed the uselessness of measures of disinfection as well as the harmlessness of the undisinfected excreta of cholera-patients. If the poison of cholera be contained in the excreta, then, individual predisposition aside, those who mostly come in contact with the excreta ought to be most frequently affected. And these should be the various physicians and nurses in hospitals devoted to the care of cholera-patients. But experience has clearly shown that the medical attendants in cases of cholera are not more prone to take the disease than others. The like holds good of nurses. Let us first of all consider how the facts stand in the home of cholera, in India. During 1867, in which the epidemic at Hurdwar prevailed, James Cuningham investigated the relationship of cholera to nurses in forty garrison towns containing sixty-seven hospitals; of the sixty-seven hospitals only eight

* Reprint of a special translation made for the London "Lancet."

gave instances of cholera in the nurses; the largest number of cases occurred at Dharmsala, where there were eleven, Kasanli had three, Muttra and Moradabad each two, Fazabad, Lakhnau, Mirat, and two others one each. An epidemic among the nurses can therefore only be spoken of in the hospital of the First Ghorka Regiment stationed at Dharmsala, where eight nurses, two porters, and one other officer were taken ill of the disease. These statements show how exceptional such occurrences are. Why should not a hospital as well as a garrison now and again be a center of infection? Closer investigation proves, however, that the *personnel* of the hospital at Dharmsala was not affected in a greater degree than the population outside the hospitals. It may be shown that the percentage of cases of cholera among the outside population was 8·01; in other words, that eighty-six cases occurred out of 1,073, while of the hospital staff of 127 eleven fell ill, or a percentage of 8·66. Cuningham also inquired whether the immunity enjoyed by nurses could be explained by disinfection. He found from ancient sources that this striking immunity of nurses was by no means a new thing, and had certainly obtained before the days of disinfection. He draws attention, among other writings, to an experience of Dr. Bruce, who wrote: "In 1848 cholera broke out among the infantry at Caenpur from May to September. During the whole time the hospital was never free from single cases of cholera, and at times it was overfilled with them. The whole institution may be said to have lived in the rooms of the sick; the coolies did not leave the beds of the sick for an hour together, the physicians had much to do with the treatment of the patients; and yet not a man, whether European, half-caste, or native, showed a single symptom of cholera. I took the greatest pains to collect and sift these circumstances, but in this year not a single instance occurred." In India a practical use is made of this knowledge under the exceptional circumstances of the nurses being attacked. Nothing is said of isolation and disinfection; but the site on which the hospital stands is looked upon as unfavorable, and a change is made. This change of place is called by the English a movement, and as a prophylactic measure comes within the first ranks. If the site to which a movement has been made prove to be more unfavorable than that which was quitted—from the frying-pan into the fire—the movement has not availed anything. No good comes of the movement if the *personnel* has been already infected as much as possible. The Sixty-sixth Ghorka Regiment in its march through Tarai was not spared when it reached the Naini Valley; but, probably, if it had stayed a day longer in Tarai, the percentage of illness, instead of being ten, would have been twenty. It is the same as regards nurses and hospitals in Europe. I shall refer to Munich intentionally, not because it had so frequently been the seat of cholera (Munich had cholera once to Berlin's twelve times), but because I am better acquainted with the particulars. During the epidemic of 1873–'74 we had three hospitals

—the hospital on the left bank of the Isar, in Lindwurmstrasse, and that on the right bank of the river in Ismaningenstrasse, and the military hospital in Oberwiesenfeld. Cholera behaved in each hospital just as it behaved in the houses in their immediate neighborhood. Cases of cholera appeared in all three hospitals. In that on the left bank of the Isar there was rejoicing on account of the supposed success of isolation and disinfection until August 15th, when the summer epidemic reached its height; then an epidemic suddenly broke out. This was at the time that the epidemic developed in Lindwurmstrasse, in which the hospital was situate, and the epidemic in the hospital subsided as the epidemic in the street gave way. In the hospital on the right bank of the Isar the rejoicings lasted longer. The Ismaningenstrasse took no part in the summer epidemic, and neither did the residents of the hospital. But in the winter epidemic the same course of affairs took place as had occurred on the left bank of the river. The military hospital escaped all along. Of the seven barracks in Munich any cases or suspected cases of cholera were immediately sent to the military hospital. Now and again a surgical patient or a patient suffering from other illness than cholera was put among other patients, and later on suffered from cholera. Such cases were of course removed to the cholera division as soon as the stools betrayed the case. At times the cholera division was very full, and many nurses were employed therein; but none of these fell ill or gave the least indication of cholera, though many of them must have come in very close relation with the cholera-stools. In the military hospital in Müllerstrasse the same facts were observed as were met with in the case of the other hospitals. Seeing how little contagious cholera is among the nurses, it appears very remarkable that the washers of cholera-linen should suffer so much. I think I hear a contagionist say that why nurses of cholera-patients in hospitals are not infected may be easily explained when it is borne in mind that great cleanliness exists, that there is much washing of hands, that they do not eat with unwashed hands, and that whatever spurts on their clothes is rapidly dried, and dryness kills the bacillus. On the contrary, among the washers of cholera-linen it is easy to imagine that drops may be spurted into the mouth, or that infective material may be conveyed on wet fingers to the lips, and if a solitary bacillus gets into the intestines cholera may occur. How can this be seriously discussed? Can it be supposed that the nurses wash their hands only in certain hospitals, and during certain times, and that the chances of taking in the bacilli are less during the cleansing and attention to a patient than in washing the clothes? Do such nurses never put the moistened fingers to their lips? Do their noses never itch? The explanation of the contagionists appears to me to be very comical. And yet there are cases in which the infection must have been derived from the linen soiled by cholera-stools. A very interesting case came under my observation at Lyons in the washing-village

of Craponne. In the "Gazette Médicale de Lyon" for 1854, page 252, we read from a letter by Dr. Gensoul: "In the month of July, 1854, two fugitives, a man and his wife, from cholera, alighted from Marseilles at the Milanese court. They had hardly arrived before they were attacked by cholera, the germs of which they had brought with them, and both died on July 17th. Some days later the washers of the Gasthof Bouchard in Craponne, a village about twelve kilometres from Lyons, came to fetch the linen for the wash. The soiled clothes and linen of the cases of cholera were given out in a separate bundle, placed in a separate part of the cart, and finally given to a washer-woman to clean. The washer-woman was struck down by a rapidly fatal cholera, and the washer's daughter shared the same fate. No other cases of cholera existed in the district on which the blame could be thrown. Such a choice of victims needs no comment." The cholera was not limited to the two cases. J. Garin ("Gazette Médicale," p. 309) says that eight cases of death followed in Craponne, and among them the washer's wife. From the statistics of Dr. Garin it is gathered that the disease attacked almost exclusively the washing-folk and their children. The population of Craponne numbers about 1,600 inhabitants, several families of which have charge of the washing for the hotels of Lyons. As a later report of Dr. Bouchet showed, there were besides twenty-five other cases of cholera, with fifteen recoveries and ten deaths, which occurred in the course of two months. The year 1854 was that in which the lower-lying parts of Lyons were invaded by an epidemic. It remains a striking fact that in the fair-sized village of Craponne cholera attacked almost exclusively the laundry-workers. With the exception of the washers, Craponne might be regarded as a place free from cholera. In 1855 severe epidemics prevailed in villages near Lyons—e. g., St. Bonnet and St. Laurent de Mure—though the outlying districts always enjoyed immunity from cholera. The same held good of other exempt districts. A very instructive example of this kind is furnished by Stuttgart in 1854, which is usually exempt from cholera. At the time when the severe epidemic prevailed at Munich an inhabitant of Stuttgart left Munich while he was suffering from diarrhœa, and arrived at Stuttgart, where he became worse and died of cholera. A few days later a case occurred in the person of a woman who had never left Stuttgart. She was the nurse of the case which had come from Munich. This case might be quoted as one of direct contagion. Again, after some days, a third case appeared, and this time it was the washer-woman who had cleaned the clothes of the first case. Finally, the washer-woman's husband suffered from cholerine. But no further cases appeared. Such cases are always wrongly interpreted by the contagionists as examples of direct infection, and such, at first sight, appears to be the case. If the case from Munich had infected the three at Stuttgart, how was it that none of the three infected other individuals? For it must be remembered

that the cases at Stuttgart and at Craponne must have been tended and their linen washed. How was it that no further cases occurred, and that an epidemic was not started? The linen of the case from Munich was poisonous, but not that from the cases at Stuttgart! Must we not also suppose that another factor is necessary to explain the further spread of cases introduced from without? And this local factor was wanting at Craponne and Stuttgart. If a case from Munich caused three at Stuttgart, then the latter ought to produce nine. In places which enjoy immunity from epidemics it is conceivable that sporadic cases may occur, but, the conditions which are necessary for the production of an epidemic being wanting, no further development can take place. The soiled linen appears to me to be infective not because it comes from cases of cholera, but on account of its arrival from a locality where cholera prevails. Perhaps linen is a good vehicle for transmitting the infective material produced in a locality under the necessary circumstances of time and place. Man is the only creature that wears linen, and perhaps he alone spreads cholera, and it is possible that whether he were clothed or naked he would spread it just as much and no more. But, if we accept this doubtful solution of the Gordian knot, still the views of the contagionists on the dejecta of cholera and the soiled linen would not stand on a firmer basis, since we see not only individual cases but actual epidemics arising without the introduction of soiled linen. The infective material which produces cholera may be transmitted at all events in other ways along the paths of human intercourse. The germs of cholera may be brought from a locality to a place where the necessary relations of time and place are not favorable for the epidemic development of cholera, and they may there slumber for a month before they develop. There is every chance for the propagation of cholera in India, and yet cholera only shows itself fitfully in districts lying outside the endemic area. If the intercourse with India be reduced to the least possible, as it was in the last century, yet cholera might still at times visit us.

Finally, I shall ask myself what can be done to ward off cholera? The measures to be adopted will be very different according to the theory adopted. According to the contagionists, the spread of epidemic cholera depends on personal and material intercourse, as well as on conditions of time and space when the germs arrive at certain localities. Moreover, the severity of the epidemic is supposed to depend on the individual susceptibility. If one of these three factors be wanting, an epidemic of cholera can not develop. Preventive measures against cholera may be devised in one of three directions: (1) intercourse; (2) disposition in time and place; (3) individual predisposition. Measures to prevent the spread of cholera by interfering with human intercourse are, for many reasons, impracticable. If we ask ourselves what good has resulted from sanitary cordons, inspection, and quarantine, we are bound to answer, None. All these measures

have failed because they simply treat the individual, the possible case of cholera. But the germs of cholera may be transmitted in the absence of the disease as manifested by illness. Even perfect sanitary cordons and quarantine would be also valueless, for the reason that they are commenced too late. It is true that quarantine and cordons may prevent a certain quantity of the germs of cholera from entering a country, so that it will serve as much purpose as a good custom-house against smuggling. But there is a great difference between articles of commerce and germs of cholera. The germs of disease are capable of multiplication, and so the smuggling through of a few may, under suitable circumstances, be the means for the development of millions and billions. The epidemics at Toulon and Marseilles afford excellent illustrations of my argument. Paris has not yet been attacked, while all the regulations have failed to prevent the appearance of cholera at Naples. No doubt inspection of ships is a good regulation as tending to discover unhygienic conditions, but it is useless as preventing the transmission of cholera. Inspection of places where cholera prevails, the disinfection of articles coming from localities where cholera is, as well also as the places where the dead are laid, are important matters, but too much is not to be expected from these measures. The prevalence of contagious diseases like small-pox can not be much diminished by attempts to limit intercommunication. Protection from small-pox by vaccination, which leaves human intercourse free, has been followed by success. But we have not at our command a simple and sovereign remedy by means of which the individual predisposition to cholera may be done away with, and yet we can do something in this direction. Everything which tends to lower the general health and cause depression, but especially those conditions which induce diarrhœa, predisposes to cholera. To these matters every one must look for himself, and his own efforts may be aided by the advice of doctors. The organs of public health may also effect much. Medical treatment should be obtained for the earliest cases of cholera and of diarrhœa. Care must be taken by the authorities and by the community to take measures for the treatment of the sick. But the difficult point in the prevention of cholera is the predisposition in time and place. It is no use urging, as the contagionists do, that we can not change the nature of the soil. One of the established facts concerning epidemics of cholera is the tendency of the disease to rage in those quarters where the greatest filth prevails. All towns which have been provided with good drainage and water-supply have lost their susceptibility to cholera. England affords the best example of this fact. In 1849 there were recorded 53,237 deaths from cholera, in 1854 the numbers were 20,097, and in 1866 only 14,378, while from 1872 to 1874, when several epidemics prevailed on the Continent, cholera did not reach England. I do not imagine that this immunity was due to the want of predisposition to cholera as regards conditions of time. The case of Fort Will-

iam in Calcutta may be again referred to, as there, I believe, the immunity from cholera now enjoyed was due not merely to the introduction of a better supply of water, but largely also to the improvement in the other matters of hygiene.

METHODS OF TEACHING POLITICAL ECONOMY.

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A NATION is sometimes so bitterly taught by sad experience in financial errors—as was the case with France in John Law's time, and again in the issue of paper assignats during the Revolution—that, on the principle of the "burned child," it ever afterward finds that it unconsciously keeps to the right and avoids the wrong path. So that to-day France is a country where correct conceptions of money are almost universal, and her public monetary experiments are, as a rule, most admirably conducted. In somewhat the same way does the individual gain his proper knowledge of political economy. Principles must be seen working in a concrete form. The key to efficient teaching of the subject is to connect principles with actual facts; and this process must go on in the beginner's mind only through experience. By experience, I mean the personal (subjective) effort of each one to realize the working of the principle for himself in the facts of his own knowledge. The pupil must be put in the way of assimilating for himself the principles of his subject, in such a manner that he feels their truth because they are apparent in explanation of concrete things all around him. And for this purpose nothing is so useful as a sharp struggle, an effort, a keen discussion, or possibly a failure of comprehension at the time; for nothing will so awaken one to intellectual effort and finally result in the safe lodgment of the principle within one's thinking as an obstruction and its removal. That this is the aim to be always kept in view by the teacher and student is made clear, it is to be hoped, by the previous analysis of the "Character and Discipline of Political Economy." It is now my purpose to make some suggestions as to the practical methods of teaching by which this can be carried into effect:

1. The relative advantages of lectures and recitations in political economy have never, to my knowledge, been openly discussed. An experience with both methods of teaching leads me to think that the lecture system, pure and simple, is so ineffective that it ought to be set aside at once as entirely undesirable. No matter how clear the exposition of the principles may be, no matter how fresh and striking the illustrations, it still remains that the student is relieved by the instructor

from carrying on the mental processes which he ought to go through for himself. In fact, the clearer the exposition by the lecturer, the less is left to the student—the lecturer, in fact, is the chief gainer by the system. Moreover, while listening to a connected and logical unfolding of the principles, the student is lulled into a false belief that, as he understands all that has been so clearly presented to him, he knows the subject quite well enough; and the result is to send out a number of conceited men who really can not carry on a rational economic discussion. They wholly miss the discipline which gives exactitude, mental breadth, keenness, and power to express themselves plainly and to the point. Then, not being forced to think over a principle in its application to various phases of concrete phenomena, they know the principle only in connection with the illustrations given by the lecturer, while they utterly fail to assimilate the principles into their own thinking. The subject then becomes to them a matter of memory. They memorize the general statements without ever realizing their practical side, and that which is memorized for the day of examination is forgotten more speedily than it is learned, and the sum total of the discipline has been simply a stretching of the memory. In fact, with the average student in almost any subject the lecture system leads to cramming, At the best, it affords a constant temptation to put off that kind of internal struggle which must be gone through with—a period of doubts and questions—by which alone a clearer conception of the subject ultimately emerges. In fact, it is doubtful if the student ever gets much, if any, of that mental attrition on the subject which is the most valuable part of the work. An experience of a year in lecturing to a class of two hundred and fifty, including the best and the poorest men in the university, convinced me of the truth of the above position; and their examination-books were the most unsatisfactory I had read for years.

The usual alternative to the lecture system is the plan of recitations from a text-book. Even the simplest form of recitations is, in my opinion, better than listening to lectures. At least, the student is put to it to express the sense in words under the criticism of the teacher. But this plan has its evident difficulties. If the pupil is called upon for only what is contained in the book, he falls into the habit of memorizing, and fails to think for himself. If you give him the clew, he can tell you on what part of the page the statement is found, and can put the idea in the language of the book; but he knows nothing of the power of applying it to what he sees. If the learner is very clever and inquisitive, he may do something for himself, but the average pupil quite misses the real good of such a course.

2. As it is evident that neither lectures nor formal recitations in the old fashion are satisfactory, we are inevitably led to adopt a plan which possesses the advantages of both. Some text-book is essential as a basis for the instruction. In it the pupil should find an exposition

of the principles and a provocation to apply them to practical things as he reads. Then he comes to the class-room as intelligently familiar with the principles as his reading can make him. Now comes the work of the instructor. At first it is surprising how easy it is to show even to the best men a gap in their knowledge, or a misunderstanding of the principle. Present an illustration different from that of the book, and ask them to explain the situation. The necessity of seeing the essential point in the facts, and the attempt to describe the operation of the principle, will effectually rout the man who has merely memorized the book, and teach him to think out the matter more thoroughly for himself in the future. The teacher, also, will try to find out the accidental obstacles which in a young mind obstruct the understanding of the point in question. Let the pupil be asked to state the matter, and let the teacher note the imperfections. Now he can stimulate another student by questioning him as to one of these imperfections. If a clear correction is not obtained from a member of the class, let the instructor apply the Socratic method. At first ask a question which the learner readily understands, and then lead him naturally and gradually by logical steps up to the point wherein he had failed of understanding. He will then see his own difficulty, and at the same time he has had a little robust exercise for his mind. If this is carried on before his fellows, it will the better cultivate coolness and self-control before an audience.

3. Above all, the hour should not be wasted in simply rehearsing what has been read in the book. The student should go away from the class-room feeling that he has received some new idea, or some interesting fact which illustrates his subject. The work of the class-room should be cumulative in its effect as compared with the fruits of text-book reading. The teacher should in every way stimulate questions from members of his class, and urge the statement by them, either orally or in writing, of their doubts and difficulties. If there is some timidity in presenting a weakness in the presence of a class, ask some more manly person of the number, and the timid student will soon see that others are not much better off than he. In fact, all will have difficulties in understanding, or in interpreting principles, some trivial, some serious; and the pupil will become discouraged unless these are removed. When each one sees that others are also hindered by obstacles, there will be a greater freedom in asking questions. Moreover, in order to keep up a steady and regular training, which will produce the best disciplinary results, let the questions of the instructor every day run backward in review, and especially aim to bring out the connection of one part of the subject with another. It will be very effective if done just about the time that the past work is growing a little dim before the presence of newer ideas. In no subject, perhaps, more than in political economy, is it necessary to know the preliminary stages in order to understand the later work; so that

the pupil must be actually in possession of principles previously expounded for which he may be called upon at any time. It is simply impossible for a person to be absent and neglectful for a time in his study, and then come into the class-room to make a brilliant show on an intermediate fragment of the subject. He can be too easily exposed as a humbug to attempt it a second time. Moreover, thus to force him to do the work as he goes along is the greatest favor one can do for the pupil; and the usual cramming before the examination becomes, in reality, a general review, which is very useful in bringing him to see the connection existing throughout the whole subject.

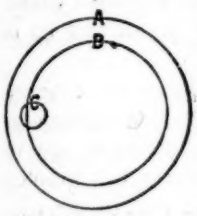
4. If the class is too large to reach each member as often as the instructor might wish in the above method, there is one device which is more or less useful. At the beginning of the hour let him write a question upon the blackboard, to be answered by each one in writing within the first fifteen minutes. The attempt to write out an explanation clearly, without hint or clew from the instructor, will reveal to the best student the deficiencies and gaps in his knowledge. Each one will then have the keenest interest to know what is considered a satisfactory answer to the question. At the next exercise of the class, the instructor can read some good and some bad answers, point out the general mistakes, and advise them for the future. No exercise can be better than this in cultivating the habit of careful expression, and in learning how to make a clear and pointed exposition of a subject in a brief space of time. This practice tends to secure the accuracy which in the oral discussions is made second to fluency and readiness.

5. Since the chief work of the class-room is not to enable students to discover principles, but rather to understand and apply them, probably the most useful method of interesting a class is to present to them by extracts from the newspapers of the day bits of fallacious discussions which may come under the head of the subject in hand, and ask for criticism and discussion of them. The appositeness of a timely topic is peculiarly valuable for such purposes. In fact, the practical matters of our own country will never fail to excite a lively interest in almost any class; and through this interest the teacher can find a way of leading men to study principles more carefully. A national or State campaign is very likely to furnish an instructor with a plentiful supply of extracts for discussion by his class. The learner in political economy is not hindered by the same disagreeable obstacles, as impede the medical student, in finding subjects on which to put his learning into practice.

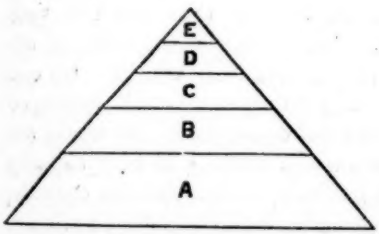
6. Many minds are unable to keep hold of an abstraction, or general principle; or they have been untrained in making nice distinctions between ideas or definitions. Just as in beginning a strange language, when words of widely different meaning have a similarity to the untutored eye, the distinctions do not make much impression. So it is in regard to ideas and definitions in political economy. There-

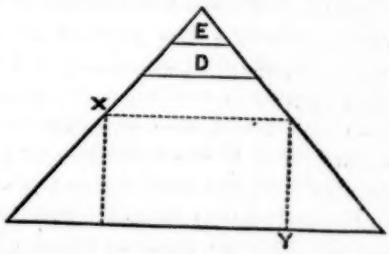
fore, visible expression of the abstract relationships, by diagrams, or by any figures which represent the abstract in a concrete form, will be of very considerable service to the ordinary student. This matter seems to me to be of such practical importance in teaching that it will be worth while to illustrate my meaning by a few examples:

(*a.*) Since material wealth comprises all things that have value; since capital is only that wealth employed in reproduction, and not used by the owner himself; and since money is that part of wealth in circulation aiding in the transfer of goods—the relations between the three may be expressed to the commonest apprehension by some such device as the following, in which the area of circle A represents the amount of wealth; B, the capital saved out of the total wealth; and C, the money by which goods are transferred—only that part of circle C being capital which, inside of circle B, is being used as a means to production.



Again (*b*), it is seen that different classes of laborers, arranged according to their skill, form, as it were, social strata, of which the largest and the poorest paid is composed of the unskilled laborers at the bottom. This may be shown to the eye at once by the sections of a pyramid, in which A represents the largest and least paid class; B, C, and D, etc., the better-educated, and relatively more skillful laborers; ending finally in the few, at the top, of the most competent executive managers. Now, if A were to become as fully skilled as B, and competition should become free between all members of A and B; and if this were to go on in the same way to include C—the effects of this breaking down of the barriers which hinder competition might be illustrated by the following changes in the above pyramid: the areas of A, B, and C may be thrown together into one area within the whole of which movement and choice is perfectly free to the laborer, and wherein wages are in proportion to sacrifice. This can be done by striking out the lines of division between A, B, and C, and by representing the change by the area included between the base and the dotted lines.





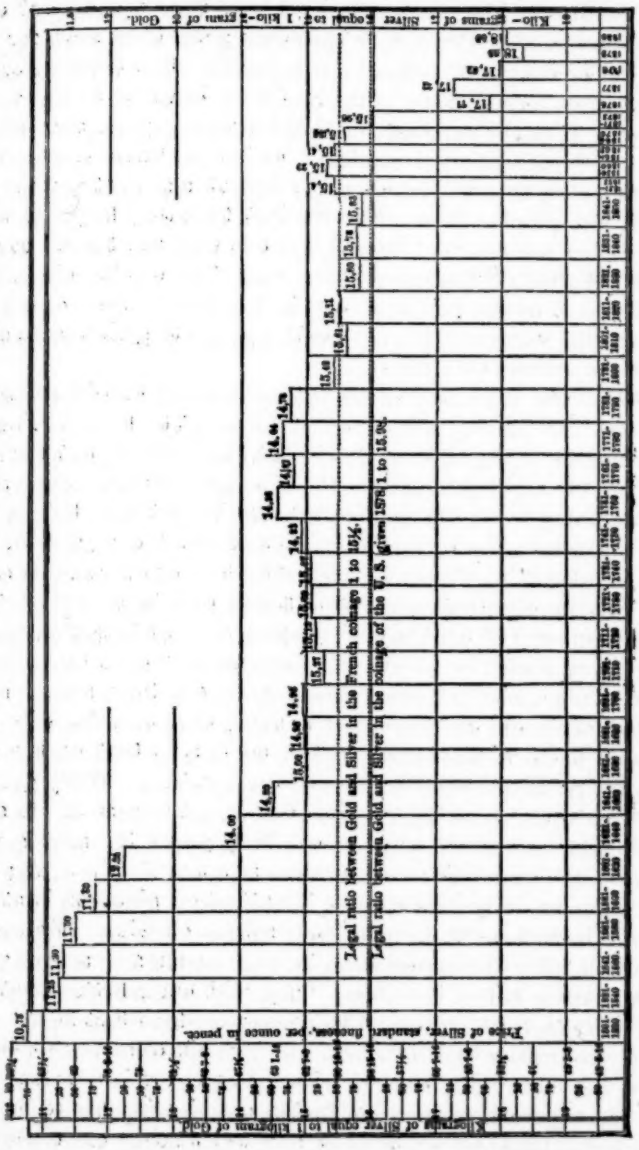
Examples might be continued in illustration of my method, but these must suffice. By this means there can be planted inside even the

dull mind an outline of an idea which can then be modeled and shaded to the condition of a natural truth. The teacher will find, by experience, that an idea thus given is very seldom forgotten. The pupil has thus once turned the abstraction into a concrete form, and he can now use it for himself after he has once grasped it. It does not at all imply that he will get hard and definite conceptions of human affairs by this process; for he is shown that the principle which he has once seen in a concrete form, appears in other forms, and he is constantly seeing that it is so.

7. In close connection with this method, but having an entirely different purpose in view, is the use of charts and graphic representations of statistics. The method just described above aimed to help in finding concrete expressions for the general principles; but graphic methods usually have as their object to assist in that part of the economic process heretofore referred to as verification. Every one knows the common dislike of dreary statistics; to many persons columns of statistics are repellent or meaningless. Collections of facts regarding banking, finance, taxation, and wages become a tangle in which one's direction is constantly lost. But arranged graphically the whole direction of a movement is seen at once, and the mind takes in new and unexpected changes, which force an investigation into their cause. Moreover, there comes a certain breadth of treatment, when, in looking at the facts graphically expressed, one is able to see the whole field at once. There is no waste of thought on temporary and accidental movements, for the action is seen from beginning to end at one glance. There are many charts which would illustrate this meaning very distinctly; but perhaps none are simpler than the one here appended, showing the steady and continuous fall in the value of silver relatively to gold since the discovery of the New World. No one has ever claimed that there has been any "unfriendliness" displayed toward silver in the legislation of the chief countries of the world before 1816, at the farthest, and yet the white metal had been steadily on the decline ever since the Spanish galleons, in the fifteenth century, began to pour the precious metals of America into the coffers of Spain.

In short, the more extended collection of economic data is now rendered possible by the better methods employed in census and statistical bureaus, and the resort to the work of verification of economic principles by the examination of these data is the one thing only which can redeem political economy from the baseless and common charge of being a set of impractical formulæ. Into this work one can carry no instrument so effective and helpful as graphic representations. In fact, the investigator, after having collected his tables and columns of figures, will find his gain in first putting them in some graphic form, before he can intelligently see exactly with what he has to grapple; then he can turn his energies directly upon the problems disclosed by the chart to every other eye as well as his own.

The slow and painful work of months is in this way presented to a class in a few minutes, and the practical lessons caught at a glance. Indeed, in most problems the difficulty is to put others in possession of


Legal ratio between Gold and Silver in the French coinage 1 to 15½.
Legal ratio between Gold and Silver in the coinage of the U. S. given 1878, 1 to 16.00.

the facts which one is about to discuss. For this purpose, charts are the labor-saving machine of statistics. They can be made on common white cotton cloth (called sarcenet), which receives ink (black or red or blue) or water-colors; or on heavy manila paper, made large

enough by sticking two large sheets together. Some printers can now rule this paper in squares to suit the convenience of the worker; but these guiding-lines ought to be faint, and not so heavy as to overpower the lines of the chart. So far I have been speaking of charts for the class-room. Perhaps, in their own good time, such economic charts can be bought of educational agencies. But ordinary co-ordinate paper, on a small scale, is the best form in which to first arrange the chart. It can be purchased in sheets at a small price, and is invaluable for both student and instructor. In fact, no lesson is more stimulating to a class than to give them the data of a subject and ask them to put it into graphic form. For the first time they begin to realize that statistics are not dry; indeed, any one who has turned over the pages of Walker's "Statistical Atlas" will find out for himself how the columns of census tables can talk to him in forms and colors without producing weariness, but even with a power to give a sense of surprise at the interest they excite.

8. When the instructor comes to examinations he will find several difficulties. In making out questions he ought to keep in view that they should be arranged so as to test not the memory, but the power of the pupil to apply principles. For this reason the ideal paper should contain nothing which the student has seen in that form before. The facts he is called upon to explain ought to be fresh ones, and the fallacies he is to examine should be such as he had not previously considered. But for practical purposes it seems best to remember that a class is composed of all kinds of persons, and, while the majority of the questions should be of the character which I have described, yet at least a few easier and more encouraging questions should be set. The student should be instructed to study each question with care; and avoid haste in answering, before he is sure that he has really caught the point and essential idea of the question. Fairly good students often write about the question, but do not answer it. It should be definitely understood that no credit is given for such answers. Then, also, the examination can be used as a teaching process; since, by inserting an important subject, the attention given to it at these times will be such as to keep it from speedy oblivion. Moreover, it will be well, after the examination, to read a good and a poor answer to each question before the class. They will know better what is expected of them in the future—like troops after their first fight. After such an examination the instructor will find his class much more disciplined and more ready to exert themselves in the intellectual wrestling. The vigorous preparation for the examination has really given them a better grasp of the subject, and the teacher can easily bring on a warm discussion now, because they really know something and feel that they know it.

9. When first approaching the study, it has been found to be of service to some students to suggest that on the first reading of the

text-book they note in the margins in a few penciled words the gist of each paragraph as it is read; then, at the close of the chapter, to advise the reader to review it by means of his marginal notes, and then make a general but brief synopsis of the chapter. This will both save time and teach that essential thing—how to study rapidly but thoroughly. It will destroy aimless reading, which is so common in these days of many books.

10. In advanced courses, much of what has been said in regard to these details will be less important, for the teaching is necessarily different in kind. Such courses naturally fall either (1) into those which continue to study principles, as the systems of various writers or schools of political economy in the past and present, or (2) into those which treat historical or practical questions. In the former the lecture system is unsatisfactory for reasons given above; and the class should themselves be constantly wrestling with the fuller discussion of subjects in which they can hitherto have had only a general knowledge. Experience seems to show that a topic, furnished with references to writers, affords the best method of procedure. This, of course, implies a good working library and a list of reserved books.

In the practical courses a large part of the training consists in teaching the student how to use books, how to familiarize himself with the principal storehouses of statistics, such, for example, as the English "Parliamentary Documents," or our own Government publications; how to collect his materials in a useful form; and then how to apply graphic representation wherever possible. The greatest good comes, of course, from putting the student on his own resources at once and forcing him to find his own materials, look up his own books and authorities, and come to a conclusion on the subject assigned to him independently of all aid or suggestion. The instructor can then at the conferences take up a paper for criticism and discussion, or first assign it to another member for that purpose. This is a feasible plan; but, if carried on throughout a whole course, it requires of the student so much time that his other work must suffer, and, in addition, but few subjects can be taken up in this thorough and leisurely way. In practice it has been found best to use the lecture system partially. One subject can be taken up by the instructor at regular exercises, for which he furnishes beforehand the references, and partly lectures and partly discusses the subject with his class, thus guiding them steadily over the field and directing the disposition of the time to be devoted to each subject. In this way many more subjects can be reached during the year. But the advantages of the investigating method can be partly retained by requiring a monograph from each member of the class on a practical subject of his own selection from a list prepared by the instructor, and this thesis can count for attendance on part of the lecture-work. In this thesis the student is pushed to do his best to give a really serious study to some particular topic, and he

is expected to do it independently of any aid beyond general oversight and direction; and he is warned that the paper will be of greater value, provided it contain the bibliography of the subject and constant reference by page and volume to his authorities.

11. The preparation of bibliographies is part of a teacher's duty. Moreover, he who has access to a rich and well-appointed library can do a service to the rest of his guild by leaving behind him notes of his bookish experiences. He can in a few words say whether a book is good or bad for a particular purpose, or indicate what part of it contains a valuable discussion, or furnishes useful facts in a subject within the study. For this purpose it has been a great convenience to have little blank-books of ordinary stiff manila paper, six inches by three, with each page perforated like postage-stamps near the butt of the book, so that each page can be torn off smoothly. On this page a book can be entered under a suitable heading, with its exact title and author, and room still be left for a very generous amount of criticism or commendation, or for noting the contents of the book. The cards can be laid away alphabetically by subjects in a drawer, and will prove of invaluable aid at many times. Books of which one has heard but never seen, can also be entered with a star, to be erased when a book has been examined. This systematic habit is peculiarly desirable when one is hunting for the facts on a certain subject. One will in this way lose nothing by forgetting where a statement has once been seen.

In this brief and inadequate way I have attempted to suggest from my own experience what may enable others to avoid difficulties, and possibly to aid in a more rational method of teaching political economy. It is scarcely more probable that what I have said is all new than that others should agree with me throughout in what I have advanced; nor is it unlikely that other teachers may have many other suggestions to make in addition to mine. If my efforts may call them out and aid in better methods of teaching, I shall be amply repaid.

LOST COLONIES OF NORTHMEN AND PORTUGUESE.*

By R. G. HALIBURTON.

NO one can find a "message from the sea," telling of the fate of some long-missing vessel, without a feeling of emotion; but the stray waifs that throw light on the history of lost colonies are of a deeper interest, for they supply missing chapters in the annals of colonization and early maritime enterprise.

* Abridged from a paper read before the Geographical Section of the British Association at Montreal.

The probable dates of those that are the subject of this paper are: 1. Vinland the Good, discovered A. D. 994; 2. Fagundes's settlement in Cape Breton, A. D. 1521; 3. A second Portuguese settlement in Cape Breton, A. D. 1567; 4. A Spanish settlement in Cape Breton, between 1580 and 1597.

I. VINLAND THE GOOD.—It is unfortunate that the early settlers ever thought of calling a place near Rhode Island *Martha's Vineyard*, for its resemblance to *Vinland* has led Danish and American archæologists to identify them as the same locality. They seem not to have remembered, that wild grapes are found on the south shore of the gulf and river St. Lawrence, from Cape North to Quebec, the Island of Orleans having for this reason been called the Island of Bacchus. Wild grapes, too, are found on the west coast of Newfoundland, according to Anspach; and in 1521 the Portuguese colonists in Cape Breton sent word home that among the products of that country were grapes. The writer of this paper has tasted some excellent wine made by a relative living at Fredericton, New Brunswick, from the wild grapes that are to be seen hanging in clusters from the elm-trees on the intervale lands along the St. John River.

But as Vinland and Martha's Vineyard were assumed to be the same, a voyage by the Northmen from Greenland, not exceeding seven or eight days, has been extended to Rhode Island, and the circumnavigation of Newfoundland and Nova Scotia has been assumed, although the Saga of Eric the Red is silent as to it, and though such a voyage, still a perilous one, was at that time a most difficult and dangerous undertaking.

The Saga of Eric the Red was written in Greenland by, or in honor of, Eric and his family, who were the discoverers, explorers, and chroniclers of Vinland the Good.

The later Saga of his son-in-law, Karlsefne, which, like the geographical notices quoted by Rafn, was written in Iceland, was evidently based, not on information derived from people who had been in Vinland, but on an imperfect version of the Greenland Saga, for almost all the courses described by them differ 90° from those given in the Saga of Eric the Red, a uniformity of error which must have arisen from the use of a sketch-map of the voyage to Vinland, in which the points of the compass were omitted or incorrectly placed. What is north in the one is generally east in the other.

We have therefore to depend on the Greenland Saga, and what are its claims to be considered a credible authority? It was written in glorification of Eric and his family, and describes the discoveries made by his sons or sons-in-law, and testified to by no one outside of his family circle.

Two persons, father and son, the latter of whom was named Eric the Red, having been guilty of murder in Norway, took refuge in Iceland, where Eric committed one if not two more murders, and in con-

sequence of them, and of his constant broils and feuds with his neighbors, was banished and outlawed. As the world was too small for him, he was tempted to try to discover and explore the new land in the West, of the existence of which there were rumors. He therefore sailed west, and discovered an ice-bound country, which he called "Greenland," because, quoth he, "people will be attracted to it if the land has a good name."

This intended fraud upon emigrants was an example that was followed in his own day, as well as in later times, for an imaginative chronicler subsequently asserted that "there is the best of wheat in Greenland."

In A. D. 994 Eric and his son Leif, having heard of new lands farther west having been sighted by Bjarne, made up their minds to explore them, and for that purpose bought and fitted out Bjarne's vessel. But Eric while on his way to the port was thrown by his horse, and took his fall as an omen that he was not destined to give any more Greenlands to the world, and he therefore allowed Leif to sail without him. But, from what we know of his proclivities, we may be quite sure that he had a wonderful name already coined for that new land—*Vinland the Good.* Could words picture a more attractive bait for emigrants?

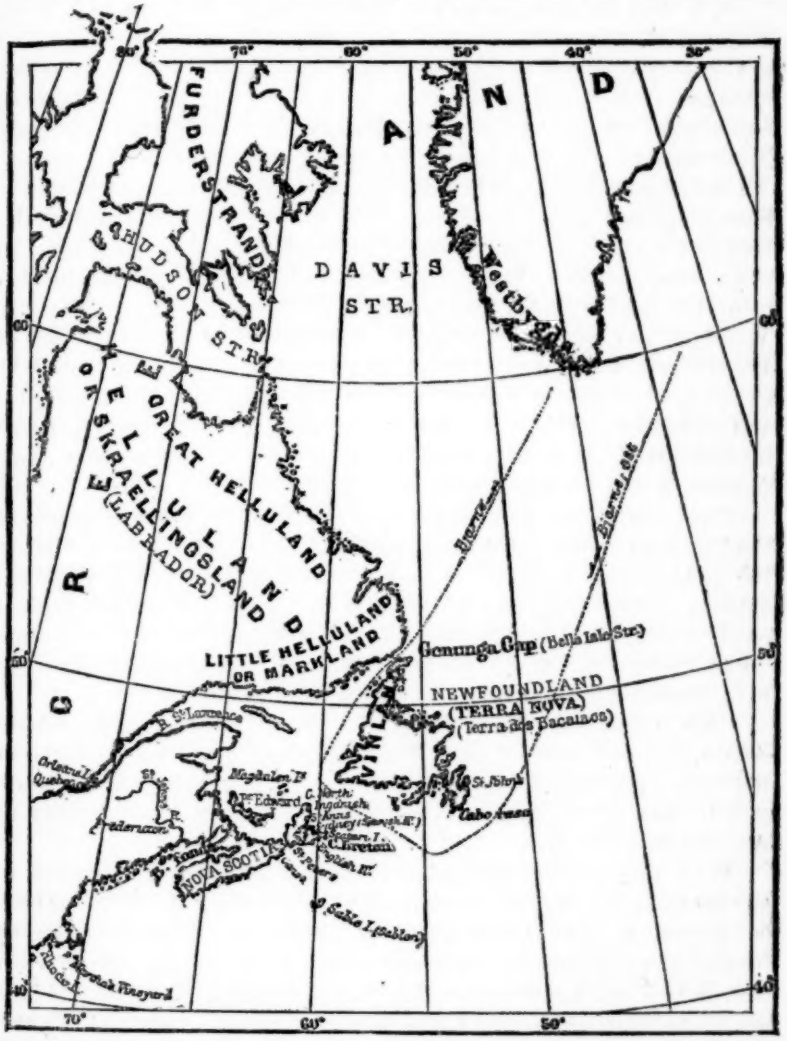
How much of the story of the subsequent exploration of Vinland by his son Leif is purely imaginary it is difficult to say. All that relates to ship-loads of grapes, self-sown fields of wheat, and the genial semi-tropical winter climate of that favored land, we may dismiss as myths or exaggerations. Where, then, was Vinland situated?

We have one test, viz., the length of the shortest day there. Professor Thorfaeus, who wrote at the beginning of the last century, found that it indicated 49° north, i. e., the latitude of Newfoundland, which was probably very near the mark, for, though Rafn contends for the latitude of Rhode Island, 41° 24′ 10″ north, the latest authority, the Icelandic-English Dictionary by Gudbrand Vigfasson (Oxford, 1874), makes the hours of sunrise and sunset 8.30 A. M. and 3.30 P. M. (instead of 7.30 A. M. and 4.30 P. M., as Rafn contends), and therefore carries back Vinland to Greenland.

There is no part of the coast from Greenland to Rhode Island which has not been pounced upon by some writer as the site of Vinland.

We can not depend on the sailing directions of the Sagas, and Captain Graah has shown that, preserved for a long time only by oral traditions, they have been changed to suit the fancy of the different persons to whom we are indebted for their preservation. We have, however, besides the length of the shortest day, another guide, viz., that the natives met at Vinland were Eskimos, or a race resembling them in their boats, etc.—such as the Naskapi, or "Mountaineers," who are found occasionally in Newfoundland. The advocates of the Rhode

Island theory, in order to explain the presence of Eskimos so far south, have started the hypothesis that the Skraellings at the beginning of the eleventh century inhabited the eastern coast of North America as far south as Rhode Island, but were driven into the Arctic regions by the races now found on the sea-coast. Not a particle of evidence can be ad-



duced to support this idea, and the authorities cited by Rafn disprove it, for an Icelandic geographer describes the more northern country, Furderstrands, as too cold for human habitations, and as bounded on the south by Skraellingsland. Their home, therefore, was then, as it still is, Labrador.

From the various accounts given by Rafn, I prepared a map, show-

ing Helluland, Markland, and Vinland, which proved to agree almost with the maps of the Northern Atlantic by the Icelander Sigurd Stephanius (1570), and by Gudbrandius Torlacius (1606), except that I made Genunga Gap run between Markland and Vinland, in accordance with one of the authorities quoted by him.

It is clear that what is now called Greenland was assumed to be an extension of the north of Europe, and that "Greenland" embraced all the country north of the Strait of Belleisle. Davis Strait was looked upon as an inlet running into Greenland, but not as a strait separating Greenland from the land to the westward. The land north of Hudson Strait was called Furderstrands, and was so cold as not to be habitable. All the country south of Hudson Strait was called Helluland, as well as Skraellingsland (our Labrador), and it was divided into Great Helluland to the north, and Little Helluland or Markland to the south. In one account, however, Little Helluland is omitted and Labrador divided into Helluland and Markland, the latter being to the south. The Westbygda of Greenland, so often referred to, was on the east side of Davis Strait, and was the site of the cathedral. Assuming such to be the case, the accounts quoted by Rafn will at once become intelligible and consistent, though totally at variance with his theory, which identifies Great Helluland with Labrador, Little Helluland with Newfoundland, and Markland with Nova Scotia.

Rafn quotes the following notice of Vinland from a fragment of the "Vellum Codex," No. 192, supposed to have been written about the end of the fourteenth century: "From Bjarmeland [in Europe] extends uninhabited land toward the north, until Greenland begins; south of Greenland is Helluland; next lies Markland; thence it is not far to Vinland the Good, which some think goes out of Africa; and if so, the sea must run between Vinland and Markland."

This, I contend, points to Newfoundland, which extends toward Africa, and is separated from Markland (Labrador) by the Strait of Belleisle. He adds, "All these countries are in that part of the world called Europe," an idea that prevailed even after the discovery of America by Columbus.

With this account agrees one of a very early date:* "Now is to be told what lies opposite Greenland, out from the bay which has been before named. The land is called Furderstrands. There are so strong frosts there that it is not habitable, so far as one knows. South from that is Helluland, which is called Skraellingsland; from thence it is not far to Vinland the Good, which some think goes out from Africa."

Hence it is clear that the Northmen placed the land of the Eskimos between a northerly uninhabitable region and the more southern Vinland.

The same description says, "Between Vinland and Greenland is Genunga Gap, which flows from the sea called Mare Oceanum, and

* "Gripla. Antiq. Am.," p. 280.

surrounds the whole earth." This is the "River Ocean" of Homer, and is used in the Eddas as the name of the watery wastes of Chaos.

Bjarne's voyage to Vinland seems to have really taken place, and to have been accurately described. The accounts of subsequent voyages appear to have been based on Bjarne's, and to be as nearly as possible mere transcripts of it reversed. In 906 Bjarne sailed from Iceland to Greenland, but "after three days' sailing, . . . the land was out of sight under the water," he was driven southward by north winds, with foggy weather for many days. At length he once more saw the sun, and having sailed one day more he sighted land. As the wind had changed from north to southwest, in which quarter it remained steady, it is evident that the northerly gale went round with the sun, i. e., to the east, then to the south, and then to southwest. Had the wind "backed" to the west and southwest, the weather would have been continued unsettled. Hence we conclude that Bjarne's vessel was driven to the banks of Newfoundland, where fogs constantly prevail, whence, the wind veering to the east, south, and southwest, he was driven into the Gulf of St. Lawrence and around Newfoundland. The land he first saw was "without mountains, and covered with wood, and had small heights." It was on his larboard side, and was probably one of the Magdalen Islands, or possibly the eastern end of Prince Edward Island. Afterward they sailed *two days*, when they saw "a flat land covered with wood." This may have been the northwest coast of Newfoundland near the west end of the Strait of Belleisle, which for a long distance is marked on Bayfield's chart as a "low limestone coast." I am informed that there are woods on it, though they may be small compared with the vast forests that are found up the rivers, whence extensive lumbering operations are now being carried on. Bjarne then put to sea for *three days*, with a southwesterly wind, and saw a third land, which was "high and covered with mountains and ice-hills." They coasted along it, and "saw it was an island." They probably sighted Labrador, and, rounding its southeast point, supposed it to be an island. Thence they sailed with the same favorable southwesterly wind (which grew into a gale) for *four days*, when they sighted a "fourth land, which was Greenland."

Leif's voyage to Vinland seems, as nearly as possible, a version of Bjarne's reversed. Neither time nor bearings are given, and we are merely told that Leif "found the land first which Bjarne had found last."* They saw no grass there. "Great icebergs were over all up the country, but like a plain of flat stones was all from the sea to the mountains." This they called Helluland. They then sailed thence and found another land which was "flat and covered with wood, and white sands were far around where they went, and the

* In the account of the Saga of Eric the Red, of Karlsefne's voyage, it is simply stated that he sailed to Vinland. The Icelandic Saga of a later date was less cautious, and gives many impossible courses.

shore was low." This was therefore called "Markland," i. e., woodland. They sailed thence for *two days* with a northeasterly wind (the opposite to that which Bjarne met with), when they sighted an island to the northward of the land, and sailed into a sound between it and a cape which ran out northwardly from the land. Thence they sailed westwardly round the cape into a place where at ebb-tide the vessel was left high and dry some distance from the shore; and when the tide rose they towed the vessel into a river, which led into a lake (or inlet?), where they landed and built booths.

If this narrative is something more than a Norse "Odyssey" or a fiction, we must infer that Leif touched at Labrador (called by him Helluland), sailed thence to some more southern part of Labrador (called by him Markland), and thence past the Island of Belleisle into one of the many shallow inlets on the south side of the Strait of Belleisle. The "low land covered with wood" and its "white sands" may possibly be the part of Newfoundland sighted by Bjarne, or it may be *Blanc Sablon*, near Bradore Bay, on the south coast of Labrador. It is, however, evident that Leif can not have reached the south coast of the Gulf of St. Lawrence, judging by the number of days expended on the voyage. The Saga of Karlsefne says that the voyage from Greenland to Helluland only took *two* days, and that from Helluland to Markland *three days*. Now, Leif's voyage from Markland to Vinland took *two days*, or the number of days spent by Bjarne in going from the land first sighted by him to the "flat land covered with wood." Bjarne's voyage from the first land sighted by him to Greenland occupied in all $2 + 3 + 4 = 9$ days.

From the Sagas of Eric the Red and of Karlsefne, we learn that the voyages from Greenland to Vinland took six days in all. Hence, Vinland, if beyond Labrador, must be sought for in Newfoundland, either in one of the shallow inlets near the Island of Belleisle, or in some place along the northwest coast of that island. The fact that grapes are found there, according to Anspach, lends some weight to this view. It is possible, too, that the Naskapi, sometimes found in Newfoundland and resembling the Eskimos in many respects, may have been included under the name Skraellings by the Northmen.

It is clear that, like Greenland, Vinland the Good was a fraud on emigrants; that the stories as to ship-loads of grapes, self-sown fields of wheat, genial winter weather, etc., were the productions of Eric's prolific brain; and that we must first succeed in finding Greenland's verdant mountains before we can hope to discover the vine-clad hills of Vinland the Good.

II. The Colony of Terra Nova, or the "Land of the Corte Reals."—The history of European colonization north of Florida has been hitherto supposed to have begun at the commencement of the seventeenth century, except perhaps a small English settlement at St. John's, Newfoundland. It has not hitherto been known to historians

that the eastern portion of British North America was the first part of the New World that was constituted a colony, that from 1500 to 1579 commissions were regularly issued to the Corte Reals as governors of Terra Nova, and that by virtue of this claim on the part of the Portuguese at least three settlements were made by the Portuguese themselves, and later by the Spaniards (after they had annexed Portugal), one of these colonies being the earliest European settlement in North America after the discovery of the New World by Cabot.

A flood of light has been shed upon this early colonization by Senhor Ernesto do Canto, of San Miguel, Azores, whose most recent publication on early Portuguese exploration consists mainly of a selection of documents connected with the family of the Corte Reals, the explorers and first governors of Northeastern America.

The information contained in Senhor do Canto's work enables me to claim for the northeastern parts of America almost a century of historical existence prior to the seventeenth century. This colony, embracing Labrador, Newfoundland, and Nova Scotia, and, under the grant to Fagundes, probably a large portion on the east coast of the present United States, was far the earliest European colony (excepting perhaps Vinland) not only in North America, but also in the New World, for the commissions of the Corte Reals date in regular succession from 1500 (i. e., two years after America had been discovered by Columbus, and six years after its discovery by Cabot) until 1579, soon after which Portugal and its possessions were annexed to Spain.

This colony of the Corte Reals was not merely a nominal one, for in the course of the sixteenth century the Portuguese made a settlement in Cape Breton in 1521, and another in 1567, while the Spaniards —their successors—sent a third to the same country. Of these three colonies little or nothing is known; even the colony of Terra Nova has lost its place in history, which begins the annals of British North America a century later with the arrival of French settlers in La Nouvelle France.

In 1500 Gaspar Corte Real explored the coast of Labrador, probably nearly as far north as Hudson Strait, and also Newfoundland and Nova Scotia. He brought back several of the natives, who resembled the present Micmac Indians. He went there again, in 1501, with three vessels, but that in which he sailed never returned. In 1502 his brother, Miguel, sailed in search of Gaspar, and met with the same fate. Again, in 1503, an expedition was sent out to try to get some tidings of the two gallant brothers, but without success, and the king, discouraged by these disasters, refused to allow Vasco Annes, the elder brother, and one of the ornaments of his court, to continue the search.

In early charts of this continent the Portuguese flag is frequently represented as waving over Labrador, Newfoundland (Baccalaos), and

Nova Scotia, which were sometimes described as the "Land of the Corte Reals," and as the "country discovered by João Alvares."

We now know that the person to whom these Christian names belonged was João Alvares Fagundes, who early in the sixteenth century carried on explorations in Northeastern America, and who, in 1521, had a grant of the country between the land of the Corte Reals and the northern boundary of the Spanish colonies, including the "terra firma and islands" discovered by him, a grant which for the first time included a portion of the United States.

Traditions as to an early settlement still linger among the Micmacs, who aver that certain earth-mounds at St. Peter's, Cape Breton, were built by white men before the arrival of the French. This belief received many years ago a confirmation by the discovery in one of these mounds of an archaic cannon formed of bars of iron fastened with iron bands or hoops, those toward the breech being the strongest. This gun attracted little attention at the time, and was broken up. My knowledge of this circumstance is derived from the historian of that province,* who for more than twenty years was on circuit in Cape Breton once, if not twice, a year. He frequently spoke of the enigma, and regretted the stupidity and utter want of interest which prevailed at that time with respect to the early history of the country. An inquiry into the date of the manufacture of such guns showed clearly that it must have been brought out before the arrival of the French in Cape Breton.† Were these remains at St. Peter's vestiges of this early Portuguese colony?

From a rare pamphlet, "Tractado das Ilhas Novas," by Francisco de Sousa, written in 1570, and published at San Miguel in 1877, Senhor do Canto, in his "Os Corte-Reaes" (pp. 89–93) copies an account of the colony in question, and has also given us a description of the discoveries, and a copy of the commission of João Alvares Fagundes.

It appears from this that the colony was planned by some noblemen at Viana, consequent upon the discoveries made by João Alvarés Fagundes. They sent out a ship and a caravel, but Newfoundland (Baccalaos) having been found too cold, the settlers sailed to the west and southwest, and, having lost their ships, were obliged to remain. News was subsequently received from them through Biscayans, who were then in the habit of frequenting that coast. They asked for priests; said that the natives were well disposed; and that the country produced "nuts, chestnuts, grapes, and other fruits, showing the goodness of the soil."

Allusions in early writers point to the existence of this early Portuguese colony. Anthony Parkhurst, in a letter published in 1578, when speaking of the excellent timber in Cape Breton, says: "I could not

* Judge Haliburton, the author's father.

† The article "Artillery," in the "Encyclopædia Britannica," says that such guns were made from 1500 to 1545, when cast-iron guns were first introduced.

find it in my heart to make proof whether it be true or no, that I have read, and heard, of Frenchmen and Portugals to be in that river" (the St. Lawrence) "and about Cape Breton. If I had not been deceived by the vile Portuguese descending of the Jews and the Judas kind, I had not failed to have searched that river and the coast of Cape Breton which might have been found out to have benefitted our country." The colony of Fagundes of 1521 has been unknown to historians, though the circumstances that led to the attempt to colonize Terra Nova have not escaped attention. Fagundes had already been an explorer, and his name is connected with the northeast coast of America by early charts, while his discoveries, as we have seen, are referred to in his commission.

We also meet with a probable reference to this colony in connection with the cattle and swine which Champlain (1618) says "were left there" (Sable Island) "more than sixty years ago" (i. e., before 1558) by the Portuguese. In Haies's report of the voyage of Sir Humphrey Gilbert, given by Hakluyt, and probably written about 1583, he says, "Sablon lyeth about twenty-five leagues to the seaward of Cape Breton, whither we were determined to go upon intelligence we had of a Portugal during our abode at St John's, who was himself present when the Portuguese (about thirty years past) did put on the said island both neat and swine to breed, which were since exceedingly multiplying."

It appears that the Baron de Lery, in 1518, landed some cattle at Canso, and the remainder on Sable Island, on his abandoning his intention of forming a settlement in Nova Scotia. It seems also probable that the Portuguese must for the same reasons have landed their cattle at Sable Island, and that the date is the probable time when the settlement of Fagundes was broken up.

III. A Portuguese Settlement at Inganish, Cape Breton, 1567.—De Laet (book ii, chapter v) tells us that the Portuguese placed Port Ningani from eighteen to twenty leagues to the northwest of the cape which afterward gave its name to the Island Cape Breton, "where they formerly had a settlement, which they have since abandoned." Champlain says that the Portuguese were forced to do this by the cold and rigorous climate.

Until recently this was all we knew about this colony, but Senhor E. do Canto has now discovered a MS. charter in the Torre do Tombo, at Lisbon, from which it appears that the king, on May 4, 1567, appointed Manuel Corte Real notary public of a colony about to be founded in Terra Nova, and for which two ships and a caravel were then about to start from Terceira. In 1579 the captaincy of that colony was conferred upon Vasco Annes, the fourth in succession of the Corte Reals. The author of the "Tractado das Ilhas Novas" appears to have sailed with the expedition of 1567, and it is quite clear that up till then no tidings from the colony founded by Fagundes had

been received. It is also clear that a Portuguese colony existed for some time at Inganish, which was abandoned on account of the cold. Was Inganish the site also of Fagundes's colony, as well as of the settlement made in 1567? It seems improbable that the colony of 1521, cut off from all communication from the mother-country for half a century, should have survived until 1567, and we are forced to conclude that the cattle and swine left on Sable Island in 1553 were the property of the Fagundes colonists, who had abandoned their settlements. It seems clear, at the same time, that the colonists who sailed in 1567 were aware that Fagundes had found Newfoundland too cold for a settlement, and had given the preference to Cape Breton. We must assume, therefore, that the colonists of 1567 settled some place in Cape Breton or Nova Scotia. Champlain says the Portuguese abandoned their settlement at Ningani (Inganish) on account of the cold. A Portuguese gentleman informed me last winter that there existed a tradition at Viana that the colony of Terra Nova was sold to the English on account of the cold climate. Senhor do Canto refers to a similar tradition, but applies it to the colony of 1521, instead of to that of 1567. This sale must have taken place after 1567, for otherwise the Portuguese, having sold out their rights to the English, would hardly have attempted, after the transfer, to make a settlement in that country.

IV. A Spanish Settlement at Sydney, Cape Breton (Spanish Harbor), between 1580–'97.—We are told that in the seventeenth century Louisburg (called English Harbor) was frequented by the English fishermen; St Ann's by the French; and Spanish Harbor by the Spaniards. Why was Sydney—at one time known as Spanish Harbor—the favorite resort of Spanish fishermen? About the time Fagundes sailed to Cape Breton, the Spaniards seemed to question his right to that country, as appears from the Spanish map of 1527, where the Spanish line of demarkation includes Cape Breton and Nova Scotia, leaving Newfoundland to the Portuguese. It is probable, however, that the Spaniards did not practically question the claims of the Portuguese, which were specially guarded in commissions to Spanish explorers. In 1580, however, the question was settled by the annexation of Portugal and its dominions by Spain. We know that toward the close of the sixteenth century a Spanish colony was sent to Cape Breton, and we can assume that it sailed some time after 1580. Our only account of it is a melancholy one, for Charlevoix says that the forty poor wretches whom the Marquis de la Roche left on Sable Island (1598) "found on the sea-shore some wrecks of vessels, out of which they built barracks to protect themselves. They were the *remains of Spanish vessels which had sailed to settle Cape Breton.*" Any one who has seen the wreck-strewed coast of Sable Island must remember it as suggesting a graveyard of vessels. Those that have been there a few years are soon covered by the drifting sands, and the half-buried skeletons of

later wrecks are to be counted by the dozen, in different stages of sepulture and decay. It is probable, therefore, that these wrecks, which were used by the French convicts, can not have been there many years previously. The date, therefore, of this Spanish expedition to Cape Breton must have been between 1580 and 1598.

An inlet in Sydney Harbor is still known as the "Northwest Arm of Spanish River."

We have no account of the fate of this colony, but we may infer that it only existed for a short time. The French took possession of and colonized that country early in the seventeenth century, and their writers are silent as to the existence of any Spanish settlement there at that time.

So thoroughly forgotten is this lost colony of Terra Nova that, though there are many Portuguese names that survive on the map of Northeastern America, they no longer suggest their origin or meaning. Few persons imagine that the Bay of Fundy is the "Deep Bay," or Baya Fonda; or that Cape Race means the "Bare Cape" or Cabo raso. The "Land of the Corte Reals" knows them no more.

RELIGION WITHOUT DOGMA.*

By GEORGE ILES.

NO purpose in the study of history is more instructive than that by which we trace the progress of freedom against authority, of inquiry as opposed to dogmatic assertion, of reason and right against arbitrary power.

As I shall have frequent need to speak of authority, it may be well to discriminate between its various species, and state with what specific meaning the term is to be used in this discourse. In the instruction of the young we all admit that authority must be the principal method employed. In early years many lessons were taught us chiefly on that principle—the rules of arithmetic, the relations of geometry, the formulas of logic, the rudiments of physics, with sundry theories as to the fluid nature of electricity and the atomic structure of matter. Besides these were lessons in history, which included the statement that Charles I was a martyr; and lastly the Church Catechism—all these did we diligently commit to memory and regard as truth. With the lapse of years came the perception that the lessons of childhood and youth were not all of equal validity. The mathematics and logic which appealed to the understanding remained, so did the largest part of physics; the hypothetic nature of electricity, however, and of the ultimate structure of matter, being deemed something else than cer-

* A lecture delivered at Montreal, Sunday, March 30, 1884.

tain. Our views of history underwent some change, and Charles I was removed from our roll of the army of martyrs. The revered sentences of the Catechism, which so tersely told the origin and destiny of all things, the nature and intentions of the Supreme Cause, were submitted to tests which left them of somewhat less force than of old. The maturing powers of reason passed judgment on the authorities, left some of them undisputed, regarded others as approaching correctness with more or less probability, and placed others, again, in the category of unsupported assertion.

As a typical case of allowable and legitimate authority, let us take the statement by Dr. Tyndall, that watery vapor, suspended in the atmosphere, acts as a powerful absorbent of heat radiant from the earth. We accept the statement because it is undisputed by physicists who are competent to execute tests of it, and because, should we choose to become instructed in the methods of research which Dr. Tyndall employs, we could verify his conclusions as many inquirers have done. Genuine authority gives us proofs, it predicts, and fulfillment follows: The geologist declares that certain strata may be coal-bearing; we sink a shaft and find the fuel. The meteorologist forecasts the weather twenty-four hours ahead, and the skies verify his prognostications. Venus, we are told from the observatory, is to cross the solar disk at a specified time, and punctually to the instant the planet appears. From elaborate consideration of the molecular groupings of certain compounds of carbon, a German chemist thought that a substance which he sought to build up from its elements would possess great beauty and value as a dye-stuff. Success rewarded his patient labor, and a new hue was placed at the disposal of the textile manufacturer. The kind of authority which men of scientific achievement exert, and which all men of special gifts of talent and character enjoy, is an authority to which we owe intelligent and cheerful allegiance. The world advances by leadership of this kind and by loyalty to such leadership. But, when a theologian says that the world was made from nothing, that man was created from the dust of the earth by instantaneous fiat, and then caused to be tempted to his fall—when we find all these assumptions made the basis of an elaborate and definite scheme of supernatural theology—we confront what seems to us the authority of unproved assertion, which reason questions and science ignores.

The history of every thinking man, in his separation of the authorities contending around him for obedience into valid and invalid, is a summary in some sort of the history of the race in its gradual emancipation from dictatorship in science, in the state, and in theology. The records of science show us the common case where men of extraordinary genius have risen so high above their fellows as to excite reverence for their results, rather than emulation of their methods. The price paid by mankind for towering ability has often been the production of generations of mere quoters and commentators, who revered the

work of a master as too sacred to require addition or improvement. Ptolemy's system of the universe was so great an advance on the explanations which preceded it, that for sixteen dreary centuries it was imposed upon students of the heavens. Not until the time of Copernicus was the theory established that the sun is the center of our system, as against the notion that the sun and planets revolve around the earth. Aristotle had such a wonderful grasp of mind, had so comprehensive knowledge, and was a man of so much constructive genius, that admiration of him paralyzed research in science for nearly two thousand years. Whewell, the historian of the inductive sciences, shows how Aristotle's Hellenic love of symmetry in thought led him to bridge gaps in evidence and induction by verbal propositions. His works presented a fictitious completeness which imposed upon students for ages. Mere comment and expansion gave place to original work only when Bacon, Galileo, and others like them, taught that the way to know Nature was to observe, experiment, and generalize. When the methods of Aristotle and Ptolemy as observers were imitated, and when their results ceased to be echoed, was science born again, to achieve wonderful victories; then the goose-step of the schoolmen became the onward march of exploration.

The revolt against the predominance of classical education in favor of that of science is a noteworthy sign of the times. Greek and Latin literatures used to be held to furnish a mental training obtainable by no other studies. Now the dominion of words is passing away. In technical schools and colleges students are brought into direct contact with the facts of Nature, and are taught how to interpret these facts into principles. It is becoming more and more widely held that the ancient literatures only provided a gymnasium for the mind, exercise wherein can be profitably superseded and included by that afforded in the tasks of the laboratory, the workshops or the botanic field. Instead of repeating Greek prose and verse, the student of science is taught skill in the use of his senses and reasoning powers, it being intended that he shall so acquire knowledge as to be able to add to knowledge.

As in the history of science and education, so in that of the state, has authority declined before the spread of the love of freedom. The history of European and American civilization is the history of the gradual recognition of the individual's rights, as against the claims of monarchy and aristocracy, of privileged persons, families, and classes. And, however imperfectly democracy may fulfill the expectations of its advocates, through freedom having often come before education in responsibility, one thing is clear, its idea is better than those which it has displaced—the idea that, as each individual man has duties to the state, he has correlative rights which entitle him to a voice in appointing those who make the laws and execute them.

In its advance from authority to freedom, the history of Christian

theology supplies a parallel to that of science and that of the state. Christianity, based on the claim of its founder to be the Lord and Saviour of men, finds its strongest and most consistent exponent in the Roman Catholic Church. That Church presents its dogmas with absolute claims to truth and infallibility, and demands the complete submission of mind and will, as the representative on earth of the Divine Saviour. The yoke of this Church, though firmly fixed about the necks of its followers, grew so burdensome at last that the Reformation arose, and belief was transferred by millions of men from the infallible Church to an infallible book, which book, however, was to be interpreted in the light of private judgment. While the ecclesiastical government of Rome was discarded, much of its creed was retained; and to this day Protestantism, in its ritualistic and more authoritative forms, is scarcely to be distinguished from its parent. Dissatisfied with the Bible as an infallible standard of faith and morals, the Liberal Churches have discarded it from its place of supreme authority and accept Christ as spiritual Lord and teacher. The Liberal fold in turn has developed a school of much influence, which, unable to bow to any external guide, looks within and finds in intuition direction sufficient for spiritual life. The history of Christianity, from the time of the apostles to that of Theodore Parker, manifests first the gradual evolution of authority, and then tells us how by abusing its power and becoming corrupt and arbitrary it incited the rebellion of bold and free men, who point by point have taken the citadels of assertion and dogma. Theology proves on examination to be no more than the views of Nature entertained by observers in the remote past. These views, formulated into creeds and crystallized into institutions, have established churches, ruled not less by the love of power than by the desire to do good.

The church-makers, in a very different spirit from that of men of science, have not dealt directly with facts, but with opinions about facts, and on examination it would appear that they have proceeded on some erroneous lines. In refusing competency to the intellect in its attempt at dealing with the problems of life, the theologians have on another hand overrated the powers of this same intellect.

While affirming the supreme mystery which infolds the universe, they have inconsistently given verbal explanations of that mystery. In the same page which speaks of the untrustworthiness and weakness of the human mind, we may find a full account of the origin and destiny of all things, and an analysis of the Divine nature and intention. The depreciation of human ability and the need of modesty in attacking the great questions of life and death are stated very forcibly, and thereupon solutions are offered us of all that a little before was declared inscrutable. In endeavoring to rise from Nature to a conception of a creating and ruling spirit, different in character from what observation of Nature would lead us to imagine that spirit to be, the-

ology has become involved in endless contradictions. The Christian idea of the Deity would seem to have been developed in the light of the sympathies which have arisen in the domestic and social life of man. These sympathies with their allied sentiments have been unwarrantably projected out beyond their proper sphere, that of human affairs, into an idea of the Divine—it being forgotten in the process that Nature in the broad view is the fullest manifestation of divine power we know, and that from Nature herself in her manifold operations should we try to integrate a conception of its informing Spirit. Hence the discrepancy between the conception of the theological Deity and the facts of the universe. Do the processes of Nature exhibit sympathy, mercy, or love? Or do we not rather observe in them the uniformity of a power manifested through an infinite mechanism which neither excuses ignorance nor spares weakness? Yet so widely and in our view so unjustifiably have the ideas of God and Nature diverged, that we find Tennyson asking, as he depicts the agony of the struggle for existence and the profuse waste of organic life, "Are God and Nature then, at strife?" Any theory of the universe which endeavors to be comprehensive must subdue the impulses of sentiment and emotion and face all the facts of experience. The natural order shows us redundant life as necessary for the competition whereby the fittest individuals and species may survive and advance. The fittest may not from the human stand-point always be the best or the highest, for the parasite, protected from contest in the stomach of a man or horse, may degenerate and assume a type lower than that in which its existence began. The system of prey, the thousands of species of parasites which make the days of so many nobler types of life miserable and short—all this does the natural order include, no less than the culminations of human consciousness, genius, and conscience which thrill us with their power as if we stood in the very presence of the Divine. Nature presents to our view and study a mechanism of infinite complexity. Its rules of action we may know in part, and, when we obey that knowledge, happiness can be ours; but, however diligent we may be in study or willing in our obedience, all its laws we can never discern, and its wheels may seize us and painfully mar or quench our lives at any moment—the lurking germs of disease by inheritance within us, or floating in the air around us, the incalculable forces of earthquake or tornado; the liabilities incidental to modern locomotion, and many of the processes of modern industry. These, together with the willful exertion of human malignity, all beset us as subtractions from joy in life. Our sympathies, baffled in their endeavor to find scope beyond the limits of human relations, return thither to their source, as perhaps to the sole legitimate sphere for their exercise. Humanity remains, though the supreme cause continue undefined. In the spirit of much of what the theologians say, we find ourselves acknowledging our inability to rise from phenomena to ultimate cause or essence.

Declining to attempt solutions of the origin and destiny of the universe, we would endeavor to attack undone work for mankind near at hand, neglecting in the mean time all discussion of the remote and impossible.

Not only in their overrating the powers of the intellect did our forefathers err, but also as seriously in their views of knowable truth did they exhibit immaturity of thought. Truth may be defined as the reality of things underlying our partial knowledge of them. Except in the limited area of axiom, our knowledge is imperfect and incomplete. On examination, it proves to consist largely of mere signs and symbols. We can state the law whereby gravitation acts, but the force itself eludes our scrutiny. We can formulate its rate and measure its quantity, but why bodies tend toward each other throughout universal Nature is as little known to our acutest physicists as to the least informed savages. All analogy requires us to think that a medium is necessary for the conveyance of the attraction, yet, if there be a medium, how does it do its work, and that too across the diameter of the visible universe with practical instantaneity? So too with the properties of substances which are surely among the simplest things we can consider. What is the essential difference between iron and lead, and why does water always freeze in six-petaled crystals? Such questions, which lie at the very threshold of the temple of inquiry, show us how hard is our task of getting below our labels, our names of things, and pursuing investigation more than a single remove from appearance.

At the risk of being tedious, I shall take an example of the growth of our information about a single substance, to illustrate the indefinitely great extensions of knowledge which are possible to us, in every direction in which we may seek it—this in contrast with the views of knowable truth which were current in the infancy of information. Iron had, doubtless, in very remote times, been observed to be tenacious and malleable; of value, therefore, in making of tools and weapons. Later on its magnetism was noticed, and, at some uncertain date, in China probably, it began to be used in navigation as the mariner's compass. The rusting of the metal must have been observed very long ago; yet it is little more than a century since that common fact was rationally explained, and since the chemical relations of iron began to be studied. Examination has determined its crystalline structure; its capacity as a transmitter of sound, heat, and electricity; and its improved tenacity, when united with carbon, to form steel. The long catalogue of its various properties does not seem to be approaching a limit, but rather the reverse. Within recent years spectrum analysis has determined the peculiar lines, several hundred in number, which enable it to be identified as a fiery vapor, alike in the flame of the laboratory or in the remote orbs of space. The telephone proves that a small disk of the metal conceals within its structure the subtile means of converting sound-waves into electrical tremors, and

these back again into audible vibrations, with so much of the individual tone of a speaker as to be readily recognizable. Now, if iron, which is comparatively so simple a thing, presents such a multitude of properties and powers, if it be shown to have relations with all else in Nature, if very important knowledge respecting it has but recently come into our possession, how very cautiously should we proceed when our subject of thought is not a chemical element, but, say, some large question of human nature or public policy! The little gray crystal of iron is eloquent in bidding us have some decent hesitation, when we are considering, say, some proposed legislation which is to affect the complex sentiments, desires, and passions of men. For lack of that decent hesitation, statute-books are filled with laws which are evaded, or work results opposed to those expected from them, all tending to establish in the popular mind an injurious contradiction between law and common sense. And what supreme diffidence should there be when we are endeavoring to arrive at, not some knowledge in a special science, not the best policy in a matter of law or state, but when we approach the highest questions: How best can we interpret Nature so as to form a conception of its informing spirit? If a man die, shall he live again? What are the sanctions and what the standard of right conduct? Which is the higher reverence, that which accepts the dictum of a local and arbitrary authority in response to these questions, or that which considers them patiently in the light of all human experience to the present day, by the aid of the highest faculties we possess? We are often told to bow to authority in the singular, but we are surrounded not by authority but by authorities, many and diverse. Among them all—religious, social, or scientific—we can but lean on such common sense as we possess to aid us in selection and discipleship.

I have defined truth to be the reality of things underlying our partial knowledge of them. Our forefathers thought of truth as a thing which they might grasp as fully and perfectly as a child's hand incloses a pebble; our conception is of something which we may approach, but never possess, save in the restricted field of axiom. We think of truth as of the dim face of a star, discerned through difficulties of distance, distortions of media, and defects of the seeing eye. The old view of finality, completeness, and perfection in knowledge, we discard as utterly disproved by fact. Science knows nothing of the infallibilities it was aforetime thought necessary to assume. The infallible standards of Church, Bible, and intuition have never yielded to inquiry more than the verbal husk of assumed certainty. Science accepts the risks of a fallibility which can not be escaped, but which it reduces to a minimum by the co-operation of many minds. The desire to be certain, which set up the oracles and established the successive infallibilities is, however, an intelligible desire. Doubt and ignorance are not pleasant states of mind to acknowledge, and the

process of arriving at fair judgments is both laborious and painful. Instead, however, of assuming certainty because it is desirable, we would endeavor to earn it, by recognizing it as every man's duty and privilege to add to truth, in the justness, completeness, and clearness of his knowledge of it. And, since the scope of the unknown is infinite, the incitement to the fulfillment of this duty is full of hope and promise. Science, unlike dogma, does not point to fields harvested and gleaned long ago, but to continents awaiting their Columbus—to pressing problems of individual, social, and political life demanding solutions by thoughtful men. And, in the fields of scientific investigation, we can see how every newly ascertained fact and law extends the horizon of Nature, adds to the area of unexplored territory, thereby stimulating the student to achievement therein. In researches respecting mind and brain, and their relations, in probing consciousness to its depths, and in the results which may follow the inquiry as to whether the intellect does or does not come into direct contact with external Nature, some of the ablest thinkers of our time place hope of more light on the chief problems of life. Our conception, then, of knowledge leads us back to the early similitude which likened it to a tree. Knowledge does not increase, like a honey-comb, cell simply added to cell, but, like an oak, whose every year of growth implies not addition merely, but vital transformation of structure. Nothing is fixed but the axis from which the branches and boughs spread out, as if they felt they had all the universe for their expansion. A stripling oak of a few seasons' growth is beautiful enough in its way; but would it be wise or useful to uproot it, shelve it in a museum, and declare it to represent a finality as to oak-possibilities?

The idea of knowledge which I have sought to express makes clear the grounds whereon thought and discussion ask for full liberty. As men differing in natural ability, temperament, education, and stand-point, strive to attain views of truth, their results must inevitably vary. "Recognition of difference of view" we would, then, substitute for the offensive term "toleration of dissent," which latter phrase, from one who holds that he possesses finality, simply means the permission of known error, which he may be unwilling or unable to punish. And the differences of view which men of opposite temperaments and tendencies may entertain are often mutually completing, and become indued in a master-mind with stereoscopic relief and unity. Let me cite an example of this: Two schools of thought endeavored to explain conscience on different principles. The one held it to arise from an innate moral sense, the other from the results of experience. The philosophy of evolution includes in its explanation both series of facts from which these two schools argued. It shows how ancestral experiences of right and wrong conduct become organized in the race, and are transmitted as moral tendencies to off-

spring. These tendencies are advanced in their progress a step by the experience of each individual life.

Having, then, expressed our dissatisfaction with the method of theological authority, from its having attempted problems which as yet are beyond the scope of the human intellect, and because of its erroneous notions as to the knowability of truth, let us endeavor to describe the method of science which we would adopt in the whole sphere of our mental activity. The scientific method is nothing very new or unfamiliar; it is simply ordinary thinking, corrected by the canons of a more exact and cautious procedure. It is organized common sense coming into contact with fact, and carefully sifting the evidence derived from fact. Business men employ it in importing or manufacturing their wares, in estimating the demands of markets, and ascertaining the standing of their employés and customers. Physicians act according to it in diagnosing their cases, prescribing treatment, or operating in surgery. Lawyers employ it in supporting their pleas and arguments; and judges use it in rendering their decisions within the limits of the written law and of their precedents. The scientific method ignores no faculty of man or fact in Nature; it recognizes to the full our emotions, affections, and sentiments, but subordinates all these to the intellect, whose dictum alone is given command over the educated will. Authority relies on inspiration, revelation, the miraculous, and the supernatural; science relies on brain, on experience, the mastery of facts by accurate and patient thought. The one receives or imagines it receives, the other acquires and has no opinion not subject to revision as new evidence comes in. It entertains no beliefs beyond evidence, and seeks none. It knows nothing of infallible guides without or within, nothing of authorities which may not be doubted and which submit no proof of their assertions. Science endeavors to substitute convictions for mere assent; and, instead of mechanical adhesion, would give to genuine authority the intelligent concurrence earned by the labor of the individual mind. It is not because science has won its chief victories in the physical world, where the comparative simplicity of its problems has invited attack, that we should therefore have an imperfect idea of its scope. Its scope includes the whole range of human thought and feeling. Science is not limited to fields where clocks and micrometers may be used to measure, or logarithmic tables be employed to compute; it recognizes human emotions, sentiments, and will. To these it would direct study, no less than to the areas where exact results are attainable.

Applying, then, the method of science to an examination of theology, it appears to consist in an attempt at explaining the facts of Nature, and the sanctions of duty, in distant ages of scant knowledge. Its scriptural revelations come down to us through centuries of untrustworthy custodians, and when they reach us at last they are not revelations to us, but hearsay about revelations, and must be judged by the

canons of criticism which we apply to other departments of literature. Every theology, no matter how emphatic its assertion of a supernatural source, bears about it the plain marks of its human origin. The conceptions of God vary with the zones and closely parallel the grades of culture in which they arise. The commandments called divine become more elevated as the civilization of a people advances. The disciples of a prophet or apostle direct the noble impulses he has implanted in their hearts to broaden his teachings and correct his errors. Contrast the almost human tribal God of Abraham, Isaac, and Jacob with the lofty idea of the Deity entertained by Isaiah. Compare this latter, again, with the universal Father whom Jesus taught his followers to worship. Mark the cumbrous legality and ritualism of the Old Testament and its silence respecting the future life; how different this from the teaching of Jesus, who exalted the spirit above the letter, valued love more than sacrifice, and assured his hearers of an immortality which made this world but a temporary scene of trial and probation! Note how the high-minded Paul saw nothing reprehensible in slavery, and compare that with the humanity of an age which gives even dumb animals rights against their owners. The evolution of thought in general is fully exemplified by thought in theology, notwithstanding its assertion of a sacred fixity. John Wesley, sensible man that he was, said that, if he were to give up his faith in witchcraft, he would give up the Bible. Yet his followers have dropped the witchcraft, and kept the Bible.

No study of human history would be valuable or just which did not recognize as a prime fact the profound religious instincts of our race. The awe inspired by the sublimity of the starry heavens, and the terrible and resistless forces of Nature—those of the volcano, the tempest, the pestilence so mysterious in its origin and spread, and the famines so devastating in the childhood of races—all these, not less than the kindly succession of the seasons, and the enjoyments of health and home, have suggested an infinite Power, the immanent sustaining spirit of universal life. The baffled hopes and aspirations of the soul, the anguish of bereaved affection, the enigmas and tragedies of life, have joined together to implant a faith in another life which shall be complement and compensation for this. As a record of man's perception of his helplessness in the combat with Nature, as a pathetic registration of his hope, fear, and remorse, the religious sentiment is entitled to our profound respect. Every sentiment, however, of the human heart, while compelling our respect or reverence in itself, awakens some less lofty feeling by its expression in institutions. The Sanhedrims and Councils of the churches, which have arisen by virtue of the religious sentiments of our race, do not appear to have been lifted above the passions and partialities of our Congresses and Parliaments. The inner heart of humility and reverence in religion we highly respect, but the churches not so highly. The inevitable

loss which attends the translation of sentiment into organization may perhaps be exemplified in the case of our instinct for justice. That instinct, one with the love of truth, in its expression as a means of self-protection against wrong, has given rise to law and the courts. Are the results of their processes such as to awaken the reverence which the sentiment of justice compels? The discrepancy between religious feeling and ecclesiasticism; the love of right and law, as practically enacted and executed, suggests the parallel gap which philosophers and poets have so often mourned—the gulf between thought and language, which leaves music to suggest much that in speech must remain inarticulate. The great artists of the world, whose masterpieces fill the generations with wonder, have lamented how far execution has lagged behind conception. The supreme dramatist does not seem to have thought his work sufficiently valuable to take any special care to hand it down to posterity.

Religious feeling by its arrival at the theistic idea has done mankind incalculable service. How potent the thought that the universe is one, and represents one uncontradicted will! How influential for good the thought that a Supreme Mind, too great to be deceived, and absolutely righteous, knows every thought and act! "Thou God seest me," has, I think, restrained evil in the mind of conscientious theists, with a directness which might have been denied to reflections as to consequence. It is not because some of us may be dissatisfied with theology that we fail to recognize its value in the past and present. Associated with moral codes, it has impressed them on minds unfit by immaturity for the responsibilities of freedom, and by dogmatic force has doubtless given stability to order. Not because the Gods of the sects seem crude and imperfect conceptions are we to expect that the religious feeling which gave rise to all these will die out in man. It will, I believe, from age to age, go on endeavoring to form a theory which shall explain the facts of human life and universal Nature, which shall impress the imagination and influence the will.

One result of science will be profoundly influential here—its arrival at the idea of Law, its perception of uniformity and constancy in Nature; the proof which, in large part, it now possesses, that the history of the universe, from nebular mist to man, illustrates causation and continuity. This idea, excluding as it does the miraculous and the supernatural, leads us to regard the history of the universe as an unbroken and consistent unfolding. In this view, every item of knowledge we attain is secure from any interference from break in the natural order. We are incited to explore relations which are unchangeable. The sense of supreme mystery will grow as the margin of the known expands and touches larger and larger circles of the unknown; but any territory we may win we will feel sure of retaining. And, although our knowledge may not be either wide or deep, still much of it will doubtless be regarded as valuable and important

throughout the future of our race. The laws of gravitation and evolution may be included by the coming man in wider generalizations, but we can scarcely conceive their being ever regarded as other than immovable and fundamental portions of truth. We are not of those who say that human knowledge is only relative to the individual consciousness, and therefore shadowy and invalid. With reverence be it said, we hold that such knowledge as we have of water or iron, to be a part, however infinitesimal, of the divine knowledge of these things.

The instituted religions have not only given us the theistic idea, but have also laid us under weighty obligations by establishing the only means of formal instruction in morals known to our race. And here let us note the damage caused by the accidental association of a moral code with a cosmogony developed in early stages of knowledge. It is not because Genesis gives an unsatisfactory account of the world's beginning, that the decalogue does not validly register the dictates of human experience, taking form in the brain of a great lawgiver. The Mosaic and all other authoritative codes of conduct, as currently held to-day, are supported by appeals to experience; then it becomes the mission of competent thinkers to revise these codes in the light of all that men have thought and done to date. It becomes the duty of science to investigate the conditions of happiness, which we must morally fulfill if we want happiness; no other standard of conduct do we know than this.

For the essence of religion, the faith that the right will win, and that we should help it to win, we are indebted to Christianity in its rationalized forms, and for that faith we thank it.

But the churches have done more than preach theism and teach morality—they have endeavored to imitate their Founder in his care for the desolate and oppressed. Countless kind and tender spirits have found in the noble philanthropies of Christianity scope for their charity and mercy. Here, as elsewhere, we do not propose, in our independence, to disinherit ourselves of anything of value which Christianity can give. The scientific conceptions of duty at which we seek to arrive are to be broadened and deepened by the sympathies which yield the highest satisfactions of man. The necessity for the greater recognition of this element in conduct was never so urgent as now. The masses of mankind born into a world abounding with pain and evil have hitherto been disposed to consider their burdens as all equally providential. They are, however, now beginning to distinguish among the ills which beset them. Some they regard as inevitable, to be borne with manly courage; others, again, as infractions of justice, preventable or remediable by proper means. There is no prevalent recoil from the disciplines of home and business life, but there is wide-spread and growing discontent at the extreme inequalities of fortune—inequalities held to be the result of bad laws, unwise customs, and downright dishonesty. The enormous sale of Mr. Henry George's

books is not, I take it, due to any popular faith that the remedy he proposes—the public confiscation of land—will right the wrongs of poverty. The consciences of the people are shocked at the immorality of the proposal. Mr. George's vast audience is attentive because he states very forcibly the anxieties and dangers which beset bread-winners amid the contingencies of the modern industrial world. When, from beyond the sea, we hear of nihilistic vengeance, socialistic uprising, and dynamite plotting, it would seem that the safeguards of civilization against a relapse into barbarism are less secure than is commonly imagined. Do not all these dangers spring from lack of sympathy between plenty and want? Not simply between plenty and want in matters of goods and chattels, but in the better things of culture and refinement. The generous man who will correct with kindness the faulty arguments of a neighbor less endowed than himself, who will cultivate in the youth of his acquaintance love of literature, of art, and of the natural sciences, is doing as much to strengthen the bonds of society as when he shares his income with the destitute and forsaken.

When I was in Ireland, four years ago, I heard many causes assigned for the prevailing discontent. My informants averred that, not less than the injustice of the landlords, had the arrogant and unsympathetic manners of many of them, and of many of their agents, served to alienate the people. In the development and satisfaction of the sympathies, let me repeat, lies the chief hope of establishing a true brotherhood among men.

Seeking happiness as our aim, we declare knowledge, and obedience to that knowledge, to be its means, and freedom its condition. The cultivation of the heart must receive our attention, not less than the improvement and equipment of the brain, if our lives are to be worthy, useful, and happy.

A SCIENTIFIC VIEW OF THE COAL QUESTION.

By G. GORE.

IT is well known that our stock of coal is not an infinite quantity, and can not last an infinite period of time. Different authorities, and those who have investigated the subject, including a royal commission, have assigned different lengths of time during which our supply is likely to last; and, according to the most reliable authorities, it can not be much less than one hundred nor much more than two hundred and fifty years.

Our abundant store of coal and its application to industrial purposes have been among the largest causes of our wealth and progress. The value of coal for those purposes depends essentially upon the fact

that it is combustible and evolves a large amount of heat in burning, and that this heat can be set free at any time and be readily converted into mechanical, chemical, electrical, and other forms of power. As an illustration of the great amount of energy contained in coal, it is well known to scientific men that each piece of it contains sufficient stored-up power to lift its own weight twenty-three hundred miles in height, or twenty-three hundred times its own weight a mile high. The only other common natural substances to be compared with it in this respect are wood and petroleum, and our stores of these are very small. It is by the expenditure of the energy contained in coal that comparatively valueless iron-ore is converted into valuable iron.

It has not been by the mere existence of large quantities of coal in this country, nor entirely by the sale of coal to foreign nations, that so much of our wealth has been obtained, but largely by the circumstance that we were the first nation to apply coal to industrial purposes on a large scale and in a great variety of ways. Other nations also possessing coal, perceiving the great success of this method, followed our example, have overtaken us, and have now rendered it increasingly difficult year by year for us to maintain our position as manufacturers.

As also large quantities of coal, petroleum, and inflammable gas are continually being discovered and utilized in other countries, and it is known that the United States of America alone contain nearly forty times as much coal as our entire stock, the time can not be very far distant when our chances of maintaining even our present position among nations by means of our coal will be considerably less than at present. It would be wise, therefore, boldly to face this serious prospect, and consider by what means our national prosperity can be maintained as our coal diminishes in quantity and increases in price, especially as our population is continually increasing and has to purchase greater supplies of foreign food.

There does exist another and inexhaustible source of wealth and progress, viz., new knowledge obtainable by means of scientific research. It is upon such knowledge, gained by experiments made to examine natural forces and substances, that we must sooner or later depend as a fundamental source of national prosperity. As fast as this knowledge is evolved by discoverers, it is applied in more immediately practical forms by numerous inventors, and then manufacturers and men of business use those practical realities in the production of wealth. This has been the order of events in the past and will be in the future; this was the way in which we got wealth out of coal. Persons of narrow views on the subject will consider the above proposition vague and unpractical; but this order of things is a great fact and unavoidable. We are the servants of Nature, and have no choice in the matter; we might as well hope to live without food as expect to advance in civilization without the aid of new knowledge.

The practical value of new scientific knowledge as a source of wealth and progress is incomparably greater than that of all the coal-deposits, petroleum-springs, and gold-fields of the earth. This great truth, though familiar to scientific investigators, is but little perceived or appreciated by our rulers or by the mass of their electors; and the chief reason for this is the fact that they possess insufficient knowledge of science. Even governments can only appreciate that which they understand, and can only act as circumstances and public opinion allow them, and when fettered by an ignorant population are powerless to preserve a nation from decay.

There can not be a more complete error than to suppose that new knowledge discovered by means of scientific research is not practical. Its immense practical value has been abundantly proved in a multitude of cases. It was largely by means of such knowledge respecting coal, its properties, constituents, and products gained by means of experiments, that coal was applied to so many uses. One of the most recent proofs of the practical value of such knowledge is the conversion of the heat of coal into electric current and light in the dynamo-electric machine and electric lamp; the entire existence of these instruments arose from new knowledge discovered in purely scientific researches by Davy and Faraday. It is not necessary to describe here the exact beginnings of gas-lighting, phosphorus-matches, photography, the voltaic battery, electro-plating, aniline dyes, telegraphy, the telephone, etc. These, and a multitude of other utilities in common use, had their earliest origin more or less completely, not in the labors of the inventor or of the more directly practical man, but in those of philosophical investigators whose experiments were made with the far more widely practical object—the discovery of new scientific knowledge.

It is not the mere possession of good things, but making the best and earliest use of them that most conduces to success. Our great stock of coal lay comparatively useless as a source of national wealth until philosophical investigators discovered its constituents and properties, and inventors applied these to useful purposes. Other nations also possessed coal, and our greater success than theirs was largely and essentially due to the fact that we were the earliest in applying it to important and varied uses. We must not wait, therefore, for those nations to discover for us new knowledge respecting natural forces and substances, but discover it ourselves, in order that we may have the first chance of applying those forces and substances to practical uses, and of offering the useful products for sale or in exchange for food and other commodities.

It is well known that a man who has no faith in medicine will not apply to a physician until death stares him in the face. Similarly the average politician and the ordinary elector, having but little knowledge of philosophical experiments or faith in them, will probably not

believe in their great practical value until national distress and panic legislation ensue. The love of money also, and the desire of acquiring it quickly without commensurate sacrifice, fostered by our having so easily obtained it by means of our coal and science, are so strong in this nation, that probably nothing but the actual loss of wealth in the form of diminished value of properties will induce capitalists and landowners to perceive and examine the scientific basis of their incomes. When, however, the stern reality of gradually increasing scarcity of coal, and consequent inability to pay for our great supplies of foreign food by means of that coal, and of articles produced by its aid, comes upon us, perhaps the statesmen and wealthy classes of this country will see the indispensable necessity of new scientific knowledge, and be more ready to promote experimental research, with a conviction that its practical results are vast, though not always direct or immediate.—*Nature.*

THE NERVOUS SYSTEM AND CONSCIOUSNESS.

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II.

MY former paper gave an outline account of the structure of the cerebro-spinal nervous system. The functions of this system were examined as far as to the cerebral hemispheres. It was said that we lacked evidence for the appearance of consciousness in connection with the activities of the spinal cord, the medulla oblongata, the pons Varolii, and the cerebellum. It was also affirmed that, if consciousness be associated with the activities of any organs below the cerebrum, this consciousness is of a general and vague kind, not the intelligence of clear perception.

The present paper is to state the functions of the cerebral hemispheres, as far as these functions are thought to be established by recent experiment and pathology.

We shall need to refresh our minds by a general view of the cerebrum. Looking at this organ from the side, we readily distinguish its so-called lobes or divisions. These are made by the fissures or furrows which dip down from the surface, penetrating, more or less deeply, the entire mass.

The prominent fissures are the fissure of Sylvius (S, Fig. 1) and the fissure of Rolando (R, Fig. 1). The fissure of Sylvius separates, in part, the temporo-sphenoidal lobe from the lobes above, and has two branches, a longer, horizontal branch (*s*), and a shorter, perpendicular branch (*s'*). If we push apart the brain-mass at the horizontal branch, we will see the nerve-matter called the Island of Reil. This is simply an additional fold of cell and fiber substance lying over the corpus

striatum. The fissure of Rolando separates the frontal lobe, F, from the rest of the brain. It begins at the great longitudinal division between the hemispheres, and pursues an uninterrupted course to within a short distance of the horizontal branch of the Sylvian fissure. Back of the fissure of Rolando is the external perpendicular fissure (E) ; it

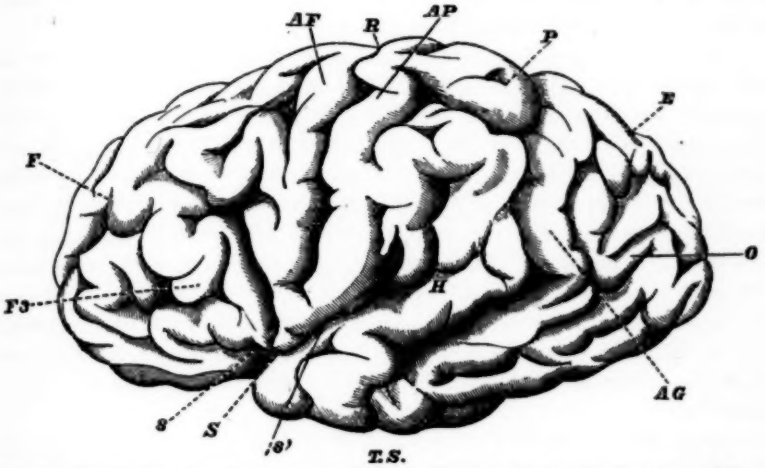


FIG. 1.—FISSURES AND CONVOLUTIONS OF THE HUMAN BRAIN. (Wundt.) Left side. *S*, Sylvian fissure—*s*, perpendicular, *s'*, horizontal, branches of this fissure; *R*, fissure of Rolando; *E*, external perpendicular fissure; F_3, third frontal convolution or convolution of Broca; *AF*, ascending frontal convolution; *AP*, ascending parietal convolution; *AG*, angular gyrus or pli courbe; *F*, frontal lobe; *P*, parietal lobe; *T.S*, temporo-sphenoidal lobe; *O*, occipital lobe.

appears as a simple notch on the upper edge of the hemisphere. It is a prolongation, on the convex or lateral surface of the brain, of the deep fissure of the internal zone. This fissure marks the rear limit of the parietal lobe (P), which therefore lies between the fissure of Rolando and this furrow. Back of the parietal lobe is the occipital lobe (O). This region is less exactly defined ; an ideal prolongation of the external perpendicular fissure would determine its anterior and inferior limits. The temporo-sphenoidal lobe (T) has already been noticed as lying below the fissure of Sylvius. Among the various convolutions formed by these fissures there are three or four which must be named, because it is with them that the experiments in brain-functions are chiefly concerned. In the frontal lobe there are two of these convolutions (F 3), the third frontal convolution, or the convolution of Broca, and (A F) the fourth frontal convolution or ascending frontal fold. Broca's convolution has somewhat the shape of a horseshoe, and is formed around the ascending branch of the Sylvian fissure. The ascending frontal fold lies directly to the left of the fissure of Rolando, which it follows throughout. In the parietal lobe we notice (A P) the ascending parietal convolution immediately to the right of the fissure of Rolando, and (A G) the angular gyrus or *pli courbe.* This latter convolution is very complex in man.

It was believed for a long time that the cerebral hemispheres were insensible and inexcitable to direct stimulation. The Germans Fritsch and Hitzig discovered, however, that parts of the cerebrum would respond to a very gentle current of electricity. This beginning has been carefully followed up by Ferrier, Munk, Goltz, and many others, until we now have, amid much disagreement and uncertainty, some results that are interesting, to say the least.

All experiments on the cerebrum are of two kinds (stimulation of the surface and destruction of the surface), and are necessarily made on the lower animals. Dupuy offered an objection to experiment by electrical stimulation, which, if well founded, would destroy the entire value of the undertaking. He claimed that the effects produced by electricity at the surface of the hemispheres were due wholly to conduction of the current through the mass to the corpora striata below and so to the muscles. Dupuy proved that conduction *did* take place through the cell-mass of the hemispheres. He placed the leg of a frog in contact with the rear of a brain, and by application of electricity to the front of this brain produced strong movements in the limb. Ferrier's answers to Dupuy are a sufficient refutation of the objection.

If the effects observed under electrical stimulation are due to conduction, we could not have (as is the case) strikingly different results from application of the electrodes to very closely adjacent areas. Further, when the striata themselves are stimulated, there is always a *general* contraction of muscles on the *entire* opposite side of the body. There is no limitation of the movements to special groups of muscles, as always happens when particular centers on the brain-surface are stimulated. Again, there are many portions of the brain which give *no response* to electrical stimulus. How can this be so if such movements as are produced result from conduction, especially since many of these silent regions of the brain are no more remote from the striata than the responsive ones?

Experiment and pathology, despite all the contradictions, seem to point to the existence of a motor zone on the surface of the hemispheres. This means that certain parts of the brain are directly concerned with the movements of particular muscles and groups of muscles; also, that these parts can not be shown to be connected with sensations. The natural, primary occasions of their activity may be the states of consciousness which we call volitions; they are not, so far as evidence goes, the states of consciousness we call sensations.

It is of interest to observe that these motor regions are situated in the anterior portions of the hemispheres, and occupy here a relatively small space. They lie above the Sylvian fissure, and are mostly on the fourth frontal and ascending parietal convolutions.

The experiments have been performed on a great variety of animals, and repeated a large number of times. The monkey is, of course,

the most interesting of these animals to us, from the striking resemblance between his brain and the human brain.

Hitzig's investigations, published in Berlin in 1874, give all the results gained up to that time by the stimulation experiments. Ferrier's book, "The Functions of the Brain," London, 1876, better known to English readers, has special merit in two respects. It displays a very intelligent comprehension of the consequences of electrical stimulation, and seems to give a juster account of the motor regions in the monkey's brain than was furnished by Hitzig.

Figs. 2 and 3 will show the character and results of these experiments in sufficient detail.

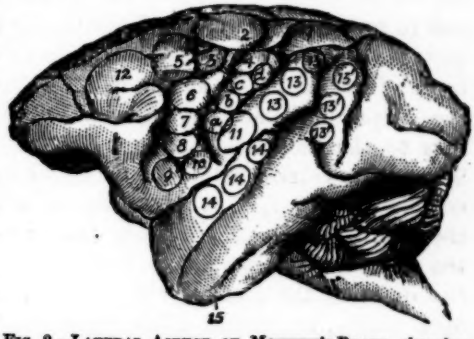


FIG. 2.—LATERAL ASPECT OF MONKEY'S BRAIN, showing the relative positions of the so-called "Motor Centers" in the left Cerebral Hemisphere. (Ferrier.)

When center No. 1 is stimulated, the hind-limb on the opposite side of the body advances as in the act of walking; when No. 5 is stimulated, the opposite arm and hand reach forward as if to touch something. These movements go together and are essentially the same. Centers 2 and 3 work together; when 2 is stimulated, there are combined movements of the opposite thigh, leg, and foot, and the foot is brought to the middle line of the body as in scratching that part, or in seizing something with the foot; 3 gives movements of the tail. An interesting fact should be noted at this point. There is no center No. 2 in the brain of cat, dog, or jackal, while No. 3 is present in each. These animals do not grasp with the foot, and the monkey alone uses the rear foot for seizing. That No. 2 should be present, and of great size, in the monkey's brain, while absent elsewhere, is confirmatory of the accuracy of the experiments. The centers marked *a*, *b*, *c*, *d*, are on the ascending parietal convolution. When stimulus is applied there, the fingers and wrist move with separate and combined movements

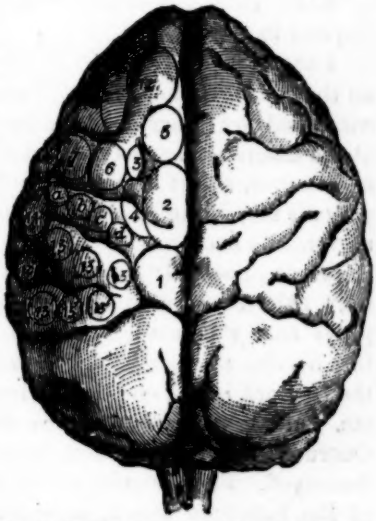


FIG. 3.—UPPER ASPECT OF MONKEY'S BRAIN, showing the relative positions of some of the so-called "Motor Centers" in the left Cerebral Hemisphere. (Ferrier.)

that end in closing the fist; in connection with these centers we may note Nos. 4 and 5; they produce movements of the opposite arm and hand. It is plain that 4 and 5, and *a*, *b*, *c*, *d*, are closely related to one another.

According to the theory of localization of functions, we should expect the centers, *a*, *b*, *c*, *d*, to be extensive in the monkey's brain, and to be wanting in the brains of lower animals. As matter of fact, they are absent in cat, dog, and jackal, except that *a* is found in the brain of the cat. This animal uses the front-paw for seizing and holding. Upon stimulating center No. 6, the fore-arm bends, and the hand lifts to the mouth. This movement is constant with the monkey. There is no corresponding center in the brain of the dog or cat. The centers marked 7, 8, 9, 10, 11, are all concerned with movements of the mouth — such as elevating the angle of the mouth, depressing the lower lip, thrusting out and withdrawing the tongue. No. 12 lies quite to the front of the brain; when it is stimulated, the eyes open widely, the pupils dilate, head and eyes turn toward the opposite side.

These are the centers in the brain which, by some authorities, are thought to have a purely motor significance. The centers marked 13, 13′, 14, and 15, give movements—the former of the eyes, the latter of the nostrils—but they are believed to be primarily connected with sensations.

Aside from the centers enumerated, no other parts of the brain respond to stimulation.

I have purposely stated the results of Ferrier's earlier experiments on the so-called motor zone. These experiments have been, in general, confirmed by other investigators. That is to say, the movements above described have been found by many to follow stimulation. It is, however, a part of the present confusion and contradiction which prevails respecting cerebral localization that the interpretation of these movements is disputed.

Munk appears ("Transactions of the Physiological Society of Berlin," 1876–1878) with a series of experiments which, as he thinks, prove that the motor zone is primarily a zone of *feeling*. He therefore divides this portion of the brain into spheres of feeling—one for the forward limbs, one for the head, one for the eyes, one for the ears, etc. Munk believes that the animal's movements are affected by destruction of these centers, because four distinct kinds of feeling are destroyed. For example, loss of the center concerned with movements of the fore-limb would, according to Munk, cause a loss—1. Of the consciousness of pressure on the limb; 2. Of the consciousness of the position of the limb; 3. Of the consciousness of the motions belonging to the limb; and, 4. Of the consciousness of touch in the limb. Whereas Ferrier and others find sensibility, both general and special, *intact* after destruction of these motor regions, Munk finds a loss of

sensibility so well defined and persistent as to justify the fourfold division above stated.

We have now to inquire as to the testimony of pathology respecting these motor areas in the brain. Charcot and Pitres, in "Revue Mensuelle," November, 1878, and February, 1879, cite fifty-six cases of brain-dieases bearing on this subject. Twenty-one of these cases show lesions in the brain outside the motor zone, and unaccompanied by motor trouble. Charcot's deductions from these cases are that "there exist in the cortex of the cerebrum tracts which are independent of voluntary motion, and when lesions occur in these tracts there are no permanent affections of the motor functions." The remaining cases cited by Charcot show lesions in the motor zone, and are accompanied by varied degrees of paralysis in keeping with the situation and extent of the lesion. Dr. Bechstrew, in the "Medicinische Wochenschrift," St. Petersburg, details a number of cases which confirm the recent views on the motor functions of the areas about the middle convolutions. Other confirmatory cases have been cited by Burdon and Maragliano, by Dr. Henry Obersteiner, and many more. It is well known, however, that a number of opposing instances are on record—that is, of lesions in the so-called motor zone without paralysis, and of paralysis unaccompanied by lesions in these portions of the brain. There is a fundamental objection to this kind of evidence: it is *selected* evidence, chosen to make for or against a theory. What we really need is a collection of *all* cases of injuries to parts of the hemispheres, and a *full* statement of consequences without regard to the bearing of the example.

This is the proper place to mention a brain disorder more or less commonly known under the name of aphasia. Aphasia is a disturbance of the power of speech. It appears in two distinct forms, viz., amnesic and ataxic aphasia. The person suffering from amnesic aphasia forgets *substantives* and *names*, other parts of speech being properly used; or he forgets a language which he once knew, or he misapplies terms, "using pamphlet for camphor, horse for man," etc. In ataxic aphasia the power of *articulation* is completely lost. The person understands fully the word to be used, and makes vigorous effort to use it, but is unable to do so. Sometimes articulation is half destroyed, so that the first part of the word can be spoken, but not the other. Sometimes automatic phrases can be uttered, such as yes and no, while it is perfectly clear that these exclamations do not satisfy the person. Another form of this general trouble is agraphia, or the inability to express ideas in writing; this is frequently complete, and all attempts at writing end in a scrawl. It is noticeable that aphasia is sometimes, though seldom, unaccompanied by insanity. As early as 1861 Broca, in Paris, expressed the opinion that aphasia was connected with disease in the third frontal convolution. While a large number of cases have been cited for and against this conclusion,

many pathologists are disposed to regard it as substantially correct. It would seem just, then, to connect these central functions which are concerned in speech with the peculiarly developed region of the human brain that lies on the anterior and lower limit of the Sylvian fissure; Wundt adds that perhaps the Island of Reil should be joined to this territory.

We are now brought to consider directly the relation of portions of the brain to specific states of consciousness. I shall state the location of the senses as formerly made by Ferrier and by Munk, and will give a specimen experiment from each investigator. Sight is located by Ferrier in the angular gyrus (A, Fig. 1), by Munk in the occipital lobe (O, Fig. 1); hearing, by both, in the temporo-sphenoidal lobe (H, Fig. 1). Ferrier places smell and taste in the lower and inner aspect of the temporo-sphenoidal lobe (U, Fig. 4). These centers are not distinguished by Munk. Ferrier names also a tactile center (H, Fig. 4). This he locates in what is known as the hippocampal region. If we separate the hemispheres from one another by cutting through the corpus callosum, we shall obtain a view of the median aspect of the hemispheres (see Fig. 4).

Attention has been called to the fact that Munk disagrees with all

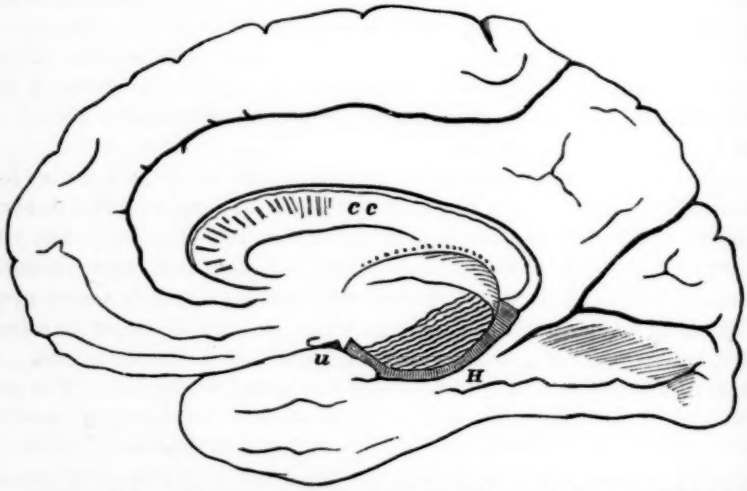


FIG 4.—MEDIAN VIEW OF RIGHT HEMISPHERE OF HUMAN BRAIN. (Ecker.) *c c*, Corpus callosum, connecting band between the hemispheres, longitudinally divided; *u*, lower and inner portion of temporo-sphenoidal lobe, center of smell, according to Ferrier; *H*, hippocampal fold, touch.

the authorities, except Schiff, in maintaining that a destruction of the motor centers destroys sensibility. Munk, therefore, does not indicate a special tactile center, but finds centers of feeling for head, neck, and back.

Ferrier's experiment with regard to vision was as follows: He chloroformed the animal, a monkey, and destroyed the angular gyrus

on the left hemisphere. He bandaged the left eye, and allowed the animal to recover from the chloroform. "Upon recovery it began to grope about a little *in loco*, perfectly alert, but would not move from its position; hearing and the other senses were not affected, for there was always a prompt reply to stimulation of these senses." The animal remained in this position for an hour. The bandage was then removed from the left eye. "It instantly looked around, ran quickly to the cage and joined its companions. When brought to the light, as before, it flinched and turned away its head." Ferrier describes the change in the animal's manner, after removal of the bandage, as most complete and remarkable. On the following day the left eye was again bandaged, but "the animal gave plain signs of vision, it ran swiftly and accurately to the bars of the cage, thrust its head between them, and began to drink from a cup of water." In his next experiment Ferrier destroyed the angular gyrus on both hemispheres. He found great difficulty in forming a right test for vision, one which should discriminate between sight as a state of consciousness and simple reflex reaction to visual stimulation.

The animal sat perfectly still and would not move from its position. "The pupils contracted to light, and light flashed in the eyes caused the animal to wince." It was utterly unwilling to move from its place; nothing else showed lack of vision. Ferrier's test was a cup of tea, which the animal liked very much. Ferrier placed the tea to the monkey's lips; it began at once to drink eagerly. The cup was then removed, but barely removed, from contact with the lips. "The monkey seemed intensely anxious to drink, but could not find the tea, though both eyes were looking straight at it." As soon as contact was established, the monkey buried his head in the cup and followed it around the room, as the cup was slowly lowered.

Munk's experiments on vision led him to different results. He removed the entire angular gyrus from the left hemisphere; he then raised the lids of the *left* eye with his fingers and touched parts of the eye softly; immediately there were blinking and vigorous movement of the head and muscles of the eye. The animal made every effort to draw back its head, and almost always accompanied these efforts by striking with the left front-limb. With the *right* eye, however, the case was entirely different. This eye could be pressed and pinched constantly, and the animal remained perfectly quiet.

If the finger or hand was brought suddenly up close to the left eye there was blinking; if to the right eye, no blinking at all resulted, unless the lids were actually touched. Munk removed the center, marked O, Fig. 1, from the occipital lobe in both hemispheres. He says: "In from three to five days after the operation there was nothing abnormal in the hearing, smell, taste, movements, or *sensations* of the animal, only in the territory of sight was there any peculiar disturbance. The animal moved about the room or garden with perfect free-

dom, he did not strike against any object, and if things were put in his way he uniformly avoided them. There was, however, a striking difference. He regarded very coldly those men whom he used to greet most affectionately. He was indifferent to the dogs he always played with before. However hungry and thirsty he was, he did not go to the corner of the room where his food was, as formerly; and, if food and water were placed directly in his path, he would go round and round them without noticing them at all. The sight of the whip, which used to drive him into the corner, did not now produce the slightest effect. He used to raise his paw when your hand was moved before his eyes; now he will not lift it, however much the hand is moved."

From these and similar facts, Munk draws a conclusion which, to say the least, seems a trifle broader than the premises. He says: "There can be no doubt about the meaning of these observations. By the extirpation of this portion of the brain, the dog has become *soul-blind.* He has lost the sight-perceptions which he once possessed; his *recollection-images* of things seen before are gone, so that he can not recognize what he sees—*still he sees;* sensations of sight come to his consciousness, so that he receives a knowledge of the existence, form, and position of external objects, but he does not know what these mean—*this* knowledge must be learned anew. The dog has been set back to his earliest years, to the time when he first opened his eyes; he must learn to see."

As removal of this part of the occipital lobe causes soul-blindness, so a removal of a portion of the temporo-sphenoidal lobe causes soul-deafness.

Until lately the defenders of localization seemed to be justified in believing that something had been established as to a motor area of the brain; they might well feel, also, that a beginning had been made toward connecting certain parts of the cortex with specific sensations and might hope that further experiment would remove, in considerable degree, the present disagreements. The doctrine of localization, both as a whole and in detail, has, however, received a severe blow at the hands of Professor Goltz, of Strasburg. In 1876 this distinguished experimenter began the publication of a series of papers in "Pflüger's Archiv für die gesammte Physiologie." In September, 1881, this series was finished and published by itself. Professor Goltz fearlessly declares that he has overthrown *all* the conclusions about division of the brain into motor and sensory areas, and brought back our knowledge of brain-function to the old view of Flourens, viz., that the cerebrum is one organ, having one function throughout. Professor Goltz's experiments were confined entirely to dogs, and their chief significance is due to the fact that he was able to keep the animal alive after removal of larger masses of the cerebrum than any other experimenter. These experiments seem to have been abundant and thorough. As a

result of them, Professor Goltz concludes that the degree of the disturbance of function from destruction of brain-substance depends upon the *quantity* removed, not upon the location of the lesion. He says, most positively, that "no extirpation of the motor centers, or of any other portion of gray matter, could cause permanent paralysis to any muscle in the body." His emphasis is upon the word permanent. Very many of the effects insisted on by advocates of localization did follow these brain-lesions, but the effects were not lasting, and they did not depend upon removal of specific portions of the substance. Blindness follows destruction of the angular gyrus, but it is temporary; the animal will see again in time. Professor Goltz admits a compensation of brain-functions, so that remaining portions of the organ may take up the work of a part destroyed; but this is not at all the compensation talked of by the supporters of localization. Their compensation requires that the additional work shall be done by the corresponding part in the other hemisphere. Professor Goltz destroys the angular gyrus on *both* sides and still his dog sees. Professor Goltz believes, however, that there are some permanent disturbances resulting from brain-lesions, such as "a certain dullness in the sensation of touch, a diminished power of vision, everything appearing cloudy to the eye, and some awkwardness in the movements." It will disturb the opponents of vivisection to know that Professor Goltz sacrificed fifty-one dogs in attempting to determine the effects of lesion in *both* hemispheres. He found that what happened only to one side of the body, and that the opposite, if one hemisphere was dealt with, happened on both sides of the body if both cerebral masses were affected. *In all these cases mental weakness increased with the increasing quantity of matter removed.* When considerable portions were taken away on both sides, the dog presented a demented appearance, very plain to be recognized. He could walk, run, see, hear, smell, and taste, but he was imbecile in all these activities.

It was not to be supposed that so fierce an attack upon localization would go unchallenged. Professor Goltz certainly did not shrink from the demand to make good his assertions. He took up basket and dog and journeyed from Strasburg to London. Here, in 1881, he came before the physiological section of the International Medical Congress, opened his basket, and, taking out the dog, placed him over against the almost equally celebrated monkey of Professor Ferrier. The dog walked, ran, saw, heard, tasted, and smelt; this was as his master desired, yet he should not have behaved so, for he had lost almost all the centers for these respective functions. Large territories in both hemispheres were gone. He was clearly weak-minded, but, on the whole, he was not the kind of dog believed in by the advocates of localization. Professor Yeo even went so far as to say before the section, "I candidly admit that, should the entire of the so-called motor centers prove to be destroyed in this case, Professor Goltz

has succeeded in completely changing my views on cerebral localization."

After the dog there was the monkey. Professor Ferrier introduced him. He had lost the motor zone in the left hemisphere seven months previously. Of him Professor Ferrier said: "As to any independent volitional action of the right arm and leg we have not seen a single indication since the operation was made. The animal is, in every other respect, perfectly well, and as to its tactile sensibility there is not the slightest sign of impairment." It is pleasing to know that, as the dog had been faithful to his master, so the monkey was true to his friend; he displayed the proper amount of paralysis on the opposite side of the body. In this connection Dr. Ireland's words are suggested. He says, "It is to be hoped, in the interest of the martyrs of cerebral physiology, that definite results will be attained as quickly and with as little suffering as possible."

Whatever may or may not be accomplished in finding definite centers of the brain for special movements and sensations, one thing stands fast—the cerebral hemispheres are the sole organs of the higher intellectual manifestations. From the time of Flourens, experiment has again and again shown that complete removal of the hemispheres is followed by stupor. All that resembles intellect disappears—spontaneous volition is gone. The animal remains buried in the profoundest repose. He originates no action. A low form of sensation and a low form of volition may remain. The animal when pinched gives evidence of pain; when set in motion, continues the motion till stopped by external hindrances. A frog deprived of the cerebrum and thrown into the water will swim until land is reached; a pigeon thrown into the air will fly until stopped by an obstacle or by exhaustion. It is to be particularly observed that the motions of these animals are strictly *normal*, i. e., pure motions; they are no longer connected with the higher power that once controlled them. They continue because they must continue.

A writer in the "Journal of Anatomy," of Paris, 1870–'71, gives a clear account of this matter. He says: "As a summary, alike in the inferior and superior animals, the removal of the hemispheres does not cause to disappear any of the movements that previously existed, but these movements assume certain peculiar characters. They are *regular*, for no psychical influence intervenes to modify them. They take place inevitably after excitation. The physiologist can, at will, in an animal deprived of the brain, determine such and such an act, limit it, arrest it. He can predict all the movements that will take place as certainly as a chemist knows in advance the reaction he will obtain from mixing certain bodies.

Pathology confirms our conclusion respecting these higher functions of the cerebrum. Loss of cerebral substance, in man, is followed by a weakening of the intellectual powers. They make a very childish

mistake who attempt to deal with the physiological materialism of our day by citing the American crow-bar case, or any number of cases of brain-loss unaccompanied by marked intellectual enfeeblement. It is equally puerile to cite instances of small brains with great intellectual power. In the first place, these small brains may be of superior quality, as small muscles often are; or, in the second place, the boasted greatness of mind may be anything and everything but greatness of mind. Learning of a very extensive kind may coexist with small mental caliber. A monkey is shrewd and quick, and cunning and smart—a parrot is learned, up in a variety of languages, speaking, as many human parrots do, some French, some Italian, some Spanish: there is no great-mindedness here.

Proof from size of the brain is, on the whole, reliable. There is, in general, a remarkable decrease in weight corresponding to the intellectual enfeeblement. Many idiots between the ages of sixteen, forty, and fifty years, have shown brains weighing 19¾, 25¼, and 22¼ ounces. There is on record the case of a deaf-mute idiot, forty-three years old, who showed an idiocy of the lowest kind, yet his brain weighed over forty-eight ounces. Such cases are not to overthrow an induction based upon a large majority of opposing instances.

It remains for the succeeding paper to consider the question propounded by the physiology of to-day, respecting the *kind* of relation which holds between the brain and consciousness. If we were to accept the judgment of the younger leading physicians, we should believe that modern Physiology had answered her own question. A distinguished physician of my city says, in his published "Lectures on Physiology": "The *so-called* voluntary movements are only the *final* responses to impressions made upon the special senses at the time or in the past. The highest expressions of the intellect of man may be resolved into the more perfect transmutations of outside forces, by machinery made more perfect by original constitution or by labor."

Without believing that such a correlation between brain and consciousness as is here asserted can be rationally accepted, there are, as I think, two general conclusions which may be drawn with certainty:

A constant relation obtains between nerve-matter and those manifestations which are usually said to belong to the soul. This relation is so important, so constant, as to determine in large measure the intellectual and moral well-being of every individual.

The origination of our states of consciousness, their character and conduct, are conditioned by physical processes antecedently occurring in the brain.

ARCTIC EXPLORATION AND ITS OBJECT.

By Dr. FRANZ BOAS.

THE severe sufferings of the last Arctic expeditions, and the losses of life and property they occasioned, have depressed the public mind in regard to Arctic explorations. Great hopes have given way to the conviction of the impossibility of penetrating the ice-bound seas and accomplishing the task which formerly seemed easy. The effect of these failures is even more profound than we could anticipate; for scientists themselves, and other men of intelligence and influence, now doubt if Arctic expeditions could be of any use either for mankind or for science. And the public mind to-day is so thoroughly imbued with these ideas, that it is necessary for every geographer to combat them with all his power.

We may be allowed to pass by the objections of men who measure the advantage of every study and of every enterprise by their influence on commercial welfare. The scientist's objections are those we wish to refute. Many do not consider the discovery of new lands and new seas a task worthy a life's work, as they do not consider it a benefit for science—for *their* science, which is the deduction of laws from facts. They do not regard the composition of the wonderful picture of the world, as Humboldt tried to delineate in his "Cosmos" a science equal in its worth to the one which abstracts physical laws that govern matter in the worlds as well as in the atoms. However, cosmography, the study of the world and its development, is not at all inferior to physics, the study of its laws.

Geography is one of the branches of science which represent the world as we see it to-day, and as it is developed into its present state. In its method and subject it is related to astronomy and history. Its domain is the study of the surface of our planet, as it has been developed by the physical action of land, atmosphere, and water, as well as by the relations between land and the organisms which live on it. Regarding geography thus in its proper place in the system of sciences, we can not be allowed to consider any one of its objects as of no consequence and not worthy of being pursued with the same perseverance as those of physics, of astronomy, or natural history. In every branch of science the connection between the phenomena and processes, and the reasons for their distribution in space and time, can only be understood by the most thorough and detailed investigation.

If it be granted that every fact added to our knowledge is of value for science, not by itself, but by connecting other facts already known, there is no reason for excluding geographical researches from this principle, or to consider discoveries of unknown regions as trifling.

For the scientist it is not the benefit of commerce which makes

the importance of geographical exploration, it is the new material added to our stock of knowledge which enables us to make new comparisons and to reach a more thorough understanding of the world. If we intend to prove the necessity of new polar explorations, we do not need to dwell upon the many observations which are connected with Arctic research. If we should enter more closely into the meteorological and hydrographical or the magnetical problems which may be understood better by researches in regions near the pole; if we should try to demonstrate the immense importance of those questions for the meteorology of our own regions, and for the hydrography of the navigable ocean, or for the closer investigation of terrestrial magnetism which is necessary for the purposes of navigation, we should leave the stand-point we try to maintain here—the principle that we are not allowed to judge the value of scientific work by its immediate importance for science and life, but by its value for science itself.

The effort has often been made to prove the necessity of continued polar exploration after the failure of so many attempts and the loss of so many brave lives, but the reasons brought forth were always those referring to the probable utility of new undertakings. It is not the proper way to defend a scientific work to point out the direct advantages which may be gained by it. Science itself has the right to ask any devotion of man for its purposes. A dangerous enterprise made in behalf of science does not need any proof of its usefulness, if it is possible to show that the results will indeed be a gain to the stock of our knowledge.

If we agree that cosmography be equal in value to physics, or even if we only understand that progress in physics can not be made except by exploring the phenomena in the most minute and detailed way, we have to concede that new explorations in the Arctic regions are of value for science, and that, therefore, they are undoubtedly necessary and must be demanded.

At the same time let us ask, What is the object of polar expeditions? It is the thorough exploration of the Arctic region and of all its phenomena, a great task which will give scientists work for years to come. The problems will not be solved by pushing north and gaining the pole. There are many more objects of study left besides, and it is not necessary at all to work with all our might for the achievement of this single aim. The desires of humanity and the wants of science both direct us the same way. The phenomena of the highest latitudes are not of a kind which requires the promptest attention. Though the reaching of the pole may be desirable, it is not so urgent as to demand the sacrifice of noble lives in hazardous and adventurous enterprises which might be accomplished with relative safety at a later time. If the problems awaiting their solution in the Arctic were as pressing as those of ethnography, any attempt to reach the pole would be justi-

fied. Physical phenomena, however, are not so subject to change as those of ethnography. Unknown tribes may be extinguished, or affected by the direct or indirect influence of civilization. The outlines of lands, the state of the weather and the sea, will not undergo alterations in the course of a few years.

Therefore we can not see any reason why polar expeditions should be sent out only in order to reach the pole. The history of former expeditions proves that the most successful results were obtained by making ample use of the experience gained in former voyages, and that most of the failures were due to ignorance of previous observations, or to the careless neglect of previous experiences. If new expeditions should be organized—and they will be organized—we shall always plead for a slow but sure progress toward the pole. From the experience gained hitherto, we are able to start at a point far north, and by studying the distribution of the land and the state of the ice yet farther north, we can conquer step by step the region hitherto unknown with comparative safety. The exploration of the pole is not a work for the bold and daring adventurer; it is the task of the careful scientist, who knows thoroughly what science will profit by every mile gained, by the study of all the phenomena of regions often passed by ships or never visited by man.

The results of a single expedition, however lucky it may be, will always be trifling as compared with the number of problems which have to be solved in the Arctic. It is quite possible that by favorable circumstances an expedition might succeed in getting far north, or discovering large areas of the unknown regions, as has happened in former years. However, the risk which the adventurers run can not be compared with the probable results. By deliberate perseverance, though the progress may be slower, the exploration of the Arctic will be accomplished in greater safety and with far greater results for science.

We wish to establish here the principle that, in the present state of affairs, daring and adventurous explorations have to be excluded from a plan of Arctic researches which is founded on scientific principles. This is not the place to determine the course which new expeditions have to take, as the discussion of this subject is not the affair of the public but of experts, who know thoroughly the phenomena of the Arctic seas and are conversant with the whole of Arctic literature. Whatever the new plans may be, the public and men of science must ask that the plan be not confined to a single expedition. The best results will be gained by considering the exploration of the polar regions as one continuous task, and fitting every new expedition into the far-seeing scheme of a thorough investigation of all the problems subject to Arctic researches. In this way we have the strong conviction that important results will be gained quicker than by spasmodic efforts now in Greenland, now in Behring Strait, now in Franz-Josef

Land. There can be no doubt that such a plan will be expensive, and not so apt to produce stirring results as any other; however, it is not the purpose of the outgoing explorers to become sufferers and enduring heroes, but to bring home results which are important for their science. The meteorological stations which were established in 1882-'83 were the first step to the organization of an enterprise like that we demand, and their results will show the utility of well-founded plans.

Hitherto I have only referred to the exploration of the unknown region never visited by men. There is more work left, however, which has to be included in a comprehensive plan of research. The southern parts of the Arctic regions—for example, the east shore of Greenland, many of the immense fjords of its west shore, Baffin Land, and the central parts of the north shore of America—are barely delineated. If we look at the charts, we might be induced to believe that most of these lands are sufficiently known, while, indeed, every new journey discloses the deficiency of our knowledge. These countries, which may be reached without serious difficulties, are the proper place for investigations of great importance, and the exploration of these parts of the Arctic is even more urgent than that of the far north, as the study of the numerous tribes which live on the shore of the Arctic Ocean has to be accomplished very soon; else the rapid diminution of those peoples and the influence of European civilization will deprive the ethnographer of anything to study but their moldering remains.

It is easily understood why, after the northwest passage was found, no new researches in this part of the world were made. Many of the explorers, or those who planned the expeditions, were often more anxious to find sensational results than to further science. Polar exploration is now mostly considered merely the ambitious struggle of expeditions to get a few miles farther north than all the former explorers. We have tried to prove, in our remarks, that its aim is much nobler, and worth all the sacrifices which are brought to it.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

I.—THE VEGETARIAN QUESTION.

IN my introductory paper I said, "The fact that we use the digestive and nutrient apparatus of sheep, oxen, etc., for the preparation of our food is merely a transitory barbarism, to be ultimately superseded when my present subject is sufficiently understood and applied to enable us to prepare the constituents of the vegetable kingdom to be

as easily assimilated as the prepared grass which we call beef and mutton."

This has brought me in communication with a very earnest body of men and women, who at considerable social inconvenience are abstaining from flesh-food, and doing it purely on principle. Some people sneer at them, call them, "crotchety," "faddy," etc., but for my own part I have a great respect for crotchety people, having learned long ago that every first great step that has ever been taken in the path of human progress was denounced as a crotchet by those it was leaving behind. This respect is quite apart from the consideration of whether I agree or disagree with the crotchets themselves.

I therefore willingly respond to the request that I should devote one short paper of this series to the subject. The fact that there are now in London nine exclusively vegetarian restaurants, and all of them flourishing, shows that it is one of wide interest.

At the outset it is necessary to brush aside certain false issues that are commonly raised in discussing this subject. The question is not whether we are herbivorous or carnivorous animals. It is perfectly certain that we are neither. The carnivora feed on flesh *alone*, and eat that flesh raw. Nobody proposes that we should do this. The herbivora eat raw grass. Nobody suggests that we should follow *their* example.

It is perfectly clear that man can not be classed either with the carnivorous animals nor the herbivorous animals, nor with the graminivorous animals. His teeth are not constructed for munching and grinding raw grain, nor his digestive organs for assimilating such grain in this condition.

He is not even to be classed with the omnivorous animals. He stands apart from all as The Cooking Animal.

It is true that there was a time when our ancestors ate raw flesh, including that of each other.

In the limestone caverns of this and other European countries we find human bones gnawed by human teeth, and split open by flint implements for the evident purpose of extracting the marrow, according to the domestic economy of the period.

The shell-mounds that these prehistoric bipeds have left behind show that mussels, oysters, and other mollusca were also eaten raw, and they doubtless varied the *menu* with snails, slugs, and worms, as the remaining Australian savages still do. Besides these they probably included roots, succulent plants, nuts, and such fruit as then existed.

There are many among us who are very proud of their ancient lineage, and who think it honorable to go back as far as possible, and to maintain the customs of their forefathers; but they all seem to draw a line somewhere, none desiring to go as far back as to their interglacial troglodític ancestors, and therefore I need not discuss the desirability of restoring their dietary.

All human beings became cooks as soon as they learned how to make a fire, and have all continued to be cooks ever since.

We should, therefore, look at this vegetarian question from the point of view of prepared food, which excludes nearly all comparison with the food of the brute creation. I say "nearly all," because there is one case in which all the animals that approach the nearest to ourselves—the mammalia—are provided naturally with a specially prepared food, viz., the mother's milk. The composition of this preparation appears to me to throw more light than anything else upon this vegetarian controversy, and yet it seems to have been entirely overlooked.

The milk prepared for the young of the different animals in the laboratory or kitchen of Nature is surely adapted to their structure as regards natural food requirements. Without assuming that the human dietetic requirements are identical with either of the other mammals, we may learn something concerning our approximation to one class or another by comparing the composition of human milk with that of the animals in question.

I find ready to hand in Dr. Miller's "Chemistry," Vol. III., a comparative statement of the mean of several analyses of the milk of woman, cow, goat, ass, sheep, and bitch. The latter is a moderately carnivorous animal, nearly approaching the omnivorous character commonly ascribed to man. The following is the statement:

	Woman.	Cow.	Goat.	Ass.	Sheep.	Bitch.
Water	88·6	87·4	82·0	90·5	85·6	66·3
Fat	2·6	4·0	4·5	1·4	4·5	14·8
Sugar and soluble salts	4·9	5·0	4·5	6·4	4·2	2·9
Nitrogenous compounds and insoluble salts	3·9	3·6	9·0	1·7	5·7	16·0

According to this it is quite evident that Nature regards our food requirements as approaching much nearer to the herbivora than to the carnivora, and has provided for us accordingly.

If we are to begin the building-up of our bodies on a food more nearly resembling the herbivora than the carnivora, it is only reasonable to assume that we should continue on the same principle.

The particulars of the difference are instructive. The food which Nature provides for the human infant differs from that provided for the young carnivorous animal, just in the same way as flesh-food differs from the cultivated and cooked vegetables and fruit within easy reach of man.

These contain less fat, less nitrogenous matter, more water, and more sugar (or starch, which becomes sugar during digestion) than animal food.

Those who advocate the use of flesh-food usually do so on the ground that it it is more nutritious, contains more nitrogenous material and

more fat than vegetable food. So much the worse for the human being, says Nature, when *she* prepares food.

But as a matter of practical fact there are no flesh-eaters among us, none who avail themselves of this higher proportion of albuminoids and fat. We all practically admit every day, in eating our ordinary English dinner, that this excess of nitrogenous matter and fat is bad; we do so by mixing the meat with that particular vegetable which contains an excess of the carbo-hydrates (starch) with the smallest available quantity of albuminoids and fat. The slice of meat, diluted with the lump of potato, brings the whole down to about the average composition of a fairly-arranged vegetarian repast. When I speak of a vegetarian repast, I do not mean mere cabbages and potatoes, but properly selected, well-cooked, nutritious vegetable food. As an example, I will take Count Rumford's No. 1 soup, already described, without the bread, and in like manner take beef and potatoes without bread. Taking original weights, and assuming that the lump of potato weighed the same as the slice of meat, we get the following composition, according to the table given by Pavy, page 410:

	Water.	Albumen.	Starch.	Sugar.	Fat.	Salts.
Lean beef	72·00	19·30	....	....	3·60	5·10
Potatoes	75·00	2·10	18·80	3·20	0·20	0·70
	147·00	21·40	18·80	3·20	3·80	5·80
Mean composition of mixture	73·50	10·70	9·40	1·60	1·90	2·90

Rumford's soup (without the bread afterward added) was composed of equal measures of peas and pearl-barley, or barley-meal, and nearly equal weights. Their percentage composition as stated in above-named table is as follows:

	Water.	Albumen.	Starch.	Sugar.	Fat.	Salts.
Peas	15·00	23·00	55·40	2·00	2·10	2·50
Barley-meal	15·00	6·30	69·40	4·90	2·40	2·00
	30·00	29·30	134·80	6·90	4·50	4·50
Mean composition of mixture	15·00	14·65	62·40	3·45	2·25	2·25

Here, then, in one hundred parts of the material of Rumford's half-penny dinner, as compared with the "mixed diet," we have forty per cent more of nitrogenous food, more than six and a half times as much carbo-hydrate in the form of starch, more than double the quantity of sugar, about seventeen per cent more of fat, and only a little less of salts (supplied by the salt which Rumford added). Thus the John Bull materials fall short of all the costly constituents, and only excel by their abundance of very cheap water.

This analysis supplies the explanation of what has puzzled many

inquirers, and encouraged some sneerers at this work of the great scientific philanthropist, viz., that he found that less than five ounces of solids was sufficient for each man's dinner. He was supplying far more nutritious material than beef and potatoes, and therefore his five ounces was more satisfactory than a pound of beef and potatoes, three fourths of which is water, for which water John Bull pays a shilling or more per pound when he buys his prime steak.

Rumford added the water at pump-cost, and, by long boiling, caused some of it to unite with the solid materials (by the hydration I have described), and then served the combination in the form of porridge, raising each portion to nineteen and three quarters ounces.

I might multiply such examples to prove the fallacy of the prevailing notions concerning the nutritive value of the "mixed diet," a fallacy which is merely an inherited epidemic, a baseless physical superstition.

I will, however, just add one more example for comparison—viz., the Highlander's porridge. The following is the composition of oatmeal—also from Pavy's table:

Water	15·00	Sugar	5·40
Albumen	12·60	Fat	5·60
Starch	58·40	Salts	3·00

Compare this with the beef and potatoes above, and it will be seen that it is *superior in every item excepting the water.* This deficiency is readily supplied in the cookery.

These figures explain a puzzle that may have suggested itself to some of my thoughtful readers—viz., the smallness of the quantity of dry oatmeal that is used in making a large portion of porridge. If we could, in like manner, see our portion of beef or mutton and potatoes reduced to dryness, the smallness of the quantity of actually solid food required for a meal would be similarly manifest. An alderman's banquet in this condition would barely fill a breakfast-cup.

I can not at all agree with those of my vegetarian friends who denounce flesh-meat as a prolific source of disease, as inflaming the passions, and generally demoralizing. Neither am I at all disposed to make a religion of either eating or drinking, or abstaining. There are certain albuminoids, certain carbo-hydrates, certain hydrocarbons, and certain salts demanded for our sustenance. Excepting in fruit, these are not supplied by Nature in a fit condition for *our* use. They must be prepared. Whether we do *all* the preparation in the kitchen by bringing the produce of the earth directly there, or whether, on account of our ignorance and incapacity as cooks, we pass our food through the stomach, intestines, blood-vessels, etc., of sheep and oxen, as a substitute for the first stages of scientific cookery, the result is about the same as regards the dietetic result. Flesh-feeding is a nasty practice, but I see no grounds for denouncing it as physiologically injurious.

In my youthful days I was on friendly terms with a sheep that be-

longed to a butcher in Jermyn Street. This animal, for some reason, had been spared in its lambhood, and was reared as the butcher's pet. It was well known in St. James's by following the butcher's men through the streets like a dog. I have seen this sheep steal mutton-chops and devour them raw. It preferred beef or mutton to grass. It enjoyed robust health, and was by no means ferocious.

It was merely a disgusting animal, with excessively perverted appetite; a perversion that supplies very suggestive material for human meditation.

My own experiments on myself, and the multitude of other experiments that I am daily witnessing among men of all occupations who have cast aside flesh-food after many years of mixed diet, prove incontestably that flesh-food is quite unnecessary; and also that men and women who emulate the aforesaid sheep to the mild extent of consuming daily about two ounces of animal tissue combined with six ounces of water, and dilute this with such weak vegetable food as the potato, are not measurably altered thereby so far as physical health is concerned.

On economical grounds, however, the difference is enormous. If all Englishmen were vegetarians, the whole aspect of the country would be changed. It would be a land of gardens and orchards, instead of gradually reverting to prairie grazing-ground as at present. The unemployed miserables of our great towns, the inhabitants of our union workhouses, and all our rogues and vagabonds, would find ample and suitable employment in agriculture. Every acre of land would require three or four times as much labor as at present, and feed five or six times as many people.

No sentimental exaggeration is demanded for the recommendation of such a reform as this.

I must apologize for this digression, as it has prevented me from closing this series with this paper, as I intended. In my next, which really will conclude, I shall describe some experiments I have recently made on the preparation of vegetable food.—*Knowledge.*

PASTEUR'S RESEARCHES IN GERM-LIFE.*

By Professor JOHN TYNDALL.

THE weightiest events of life sometimes turn upon small hinges; and we now come to the incident which caused M. Pasteur to quit a line of research the abandonment of which he still regrets. A German manufacturer of chemicals had noticed that the impure com-

* From the Introduction to "Louis Pasteur, his Life and Labors." By his Son-in-Law. New York: D. Appleton & Co, 1885.

mercial tartrate of lime, sullied with organic matters of various kinds, fermented on being dissolved in water and exposed to summer heat. Thus prompted, Pasteur prepared some pure, right-handed tartrate of ammonia, mixed with it albuminous matter, and found that the mixture fermented. His solution, limpid at first, became turbid, and the turbidity he found to be due to the multiplication of a microscopic organism, which found in the liquid its proper aliment. Pasteur recognized in this little organism a *living ferment.* This bold conclusion was doubtless strengthened, if not prompted, by the previous discovery of the yeast-plant—the alcoholic ferment—by Cagniard-Latour and Schwann.

Pasteur next permitted his little organism to take the carbon necessary for its growth from the pure paratartrate of ammonia. Owing to the opposition of its two classes of crystals, a solution of this salt, it will be remembered, does not turn the plane of polarized light either to the right or to the left. Soon after fermentation had set in, a rotation to the left was noticed, proving that the equilibrium previously existing between the two classes of crystals had ceased. The rotation reached a maximum, after which it was found that all the right-handed tartrate had disappeared from the liquid. The organism thus proved itself competent to select its own food. It found, as it were, one of the tartrates more digestible than the other, and appropriated it, to the neglect of the other. No difference of chemical constitution determined its choice; for the elements, and the proportions of the elements, in the two tartrates were identical. But the peculiarity of structure which enabled the substance to rotate the plane of polarization to the right also rendered it a fit aliment for the organism. This most remarkable experiment was successfully made with the seeds of our common mold (*Penicillium glaucum*).

Here we find Pasteur unexpectedly landed amid the phenomena of fermentation. With true scientific instinct he closed with the conception that ferments are, in all cases, living things, and that the substances formerly regarded as ferments are in reality the food of the ferments. Touched by this wand, difficulties fell rapidly before him. He proved the ferment of lactic acid to be an organism of a certain kind. The ferment of butyric acid he proved to be an organism of a different kind. He was soon led to the fundamental conclusion that the capacity of an organism to act as a ferment depended on its power to live without air. The fermentation of beer was sufficient to suggest this idea. The yeast-plant, like many others, can live either with or without free air. It flourishes best in contact with free air, for it is then spared the labor of wresting from the malt the oxygen required for its sustenance. Supplied with free air, however, it practically ceases to be a ferment; while in the brewing-vat, where the work of fermentation is active, the budding *torula* is completely cut off by the sides of the vessel, and by a deep layer of carbonic-acid

gas, from all contact with air. The butyric ferment not only lives without air, but Pasteur showed that air is fatal to it. He finally divided microscopic organisms into two great classes, which he named respectively *ærobies* and *anærobies*, the former requiring free oxygen to maintain life, the latter capable of living without free oxygen, but able to wrest this element from its combinations with other elements. This destruction of pre-existing compounds and formation of new ones, caused by the increase and multiplication of the organism, constitute the process of fermentation.

Under this head are also rightly ranked the phenomena of putrefaction. As M. Radot well expresses it, the fermentation of sugar may be described as the putrefaction of sugar. In this particular field M. Pasteur, whose contributions to the subject are of the highest value, was preceded by Schwann, a man of great merit, of whom the world has heard too little.* Schwann placed decoctions of meat in flasks, sterilized the decoctions by boiling, and then supplied them with calcined air, the power of which to support life he showed to be unimpaired. Under these circumstances putrefaction never set in. Hence the conclusion of Schwann, that putrefaction was not due to the contact of air, as affirmed by Gay-Lussac, but to something suspended in the air which heat was able to destroy. This something consists of living organisms which nourish themselves at the expense of the organic substance, and cause its putrefaction.

The grasp of Pasteur on this class of subjects was embracing. He studied acetic fermentation, and found it to be the work of a minute fungus, the *mycoderma aceti*, which, requiring free oxygen for its nutrition, overspreads the surface of the fermenting liquid. By the alcoholic ferment the sugar of the grape-juice is transformed into carbonic-acid gas and alcohol, the former exhaling, the latter remaining in the wine. By the *mycoderma aceti*, the wine is, in its turn, converted into vinegar. Of the experiments made in connection with this subject one deserves especial mention. It is that in which Pasteur suppressed all albuminous matters, and carried on the fermentation with purely crystallizable substances. He studied the deterioration of vinegar, revealed its cause, and the means of preventing it. He defined the part played by the little eel-like organisms which sometimes swarm in vinegar-casks, and ended by introducing important ameliorations and improvements in the manufacture of vinegar. The discussion with Liebig and other minor discussions of a similar nature, which M. Radot has somewhat strongly emphasized, I will not here dwell upon.

It was impossible for an inquirer like Pasteur to evade the question, Whence come these minute organisms which are demonstrably capable of producing effects on which vast industries are built and on which whole populations depend for occupation and sustenance? He thus found himself face to face with the question of spontaneous genera-

* It was late in the day when the Royal Society made him a foreign member.

tion, to which the researches of Pouchet had just given fresh interest. Trained as Pasteur was in the experimental sciences, he had an immense advantage over Pouchet, whose culture was derived from the sciences of observation. One by one the statements and experiments of Pouchet were explained or overthrown, and the doctrine of spontaneous generation remained discredited until it was revived with ardor, ability, and, for a time, with success, by Dr. Bastian.

A remark of M. Radot's on page 103 needs some qualification. "The great interest of Pasteur's method consists," he says, "in its proving unanswerably that the origin of life in infusions which have been heated to the boiling-point is solely due to the solid particles suspended in the air." This means that living germs can not exist *in the liquid* when once raised to a temperature of 212° Fahr. No doubt a great number of organisms collapse at this temperature; some, indeed, as M. Pasteur has shown, are destroyed at a temperature 90° below the boiling-point. But this is by no means universally the case. The spores of the hay-bacillus, for example, have in numerous instances successfully resisted the boiling temperature for one, two, three, four hours; while in one instance *eight hours'* continuous boiling failed to sterilize an infusion of desiccated hay. The knowledge of this fact caused me a little anxiety some years ago when a meeting was projected between M. Pasteur and Dr. Bastian. For though, in regard to the main question, I knew that the upholder of spontaneous generation could not win, on the particular issue touching the death temperature he might have come off victor.

The manufacture and maladies of wine next occupied Pasteur's attention. He had, in fact, got the key to this whole series of problems, and he knew how to use it. Each of the disorders of wine was traced to its specific organism, which, acting as a ferment, produced substances the reverse of agreeable to the palate. By the simplest of devices, Pasteur, at a stroke, abolished the causes of wine-disease. Fortunately the foreign organisms which, if unchecked, destroy the best red wines, are extremely sensitive to heat. A temperature of 50° C. (122° Fahr.) suffices to kill them. Bottled wines once raised to this temperature, for a single minute, are secured from subsequent deterioration. The wines suffer in no degree from exposure to this temperature. The manner in which Pasteur proved this, by invoking the judgment of the wine-tasters of Paris, is as amusing as it is interesting.

Moved by the entreaty of his master, the illustrious Dumas, Pasteur took up the investigation of the diseases of silk-worms at a time when the silk-husbandry of France was in a state of ruin. In doing so he did not, as might appear, entirely forsake his former line of research. Previous investigators had got so far as to discover vibratory corpuscles in the blood of the diseased worms, and with such corpuscles Pasteur had already made himself intimately acquainted. He was,

therefore, to some extent at home in this new investigation. The calamity was appalling, all the efforts made to stay the plague having proved futile. In June, 1865, Pasteur betook himself to the scene of the epidemic, and at once commenced his observations. On the evening of his arrival he had already discovered the corpuscles, and shown them to others. Acquainted as he was with the work of living ferments, his mind was prepared to see in the corpuscles the cause of the epidemic. He followed them through all the phases of the insect's life—through the eggs, through the worm, through the chrysalis, through the moth. He proved that the germ of the malady might be present in the eggs and escape detection. In the worm, also, it might elude microscopic examination. But in the moth it reached a development so distinct as to render its recognition immediate. From healthy moths, healthy eggs were sure to spring; from healthy eggs, healthy worms; from healthy worms, fine cocoons; so that the problem of the restoration to France of its silk-husbandry reduced itself to the separation of the healthy from the unhealthy moths, the rejection of the latter, and the exclusive employment of the eggs of the former. M. Radot describes how this is now done on the largest scale, with the most satisfactory results.

The bearing of this investigation on the parasitic theory of communicable diseases was thus illustrated: Worms were infected by permitting them to feed for a single meal on leaves over which corpusculous matter had been spread; they were infected by inoculation, and it was shown how they infected each other by the wounds and scratches of their own claws. By the association of healthy with diseased worms, the infection was communicated to the former. Infection at a distance was also produced by the wafting of the corpuscles through the air. The various modes in which communicable diseases are diffused among human populations were illustrated by Pasteur's treatmedt of the silk-worms. "It was no hypothetical infected medium—no problematical pythogenic gas—that killed the worms. It was a definite organism."* The disease thus far described is that called *pébrine*, which was the principal scourge at the time. Another formidable malady was also prevalent, called *flacherie*, the cause of which and the mode of dealing with it were also pointed out by Pasteur.

Overstrained by years of labor in this field, Pasteur was smitten with paralysis in October, 1868. But this calamity did not prevent him from making a journey to Alais in January, 1869, for the express purpose of combating the criticisms to which his labors had been subjected. Pasteur is combustible, and contradiction readily stirs him into flame. No scientific man now living has fought so many battles as he. To enable him to render his experiments decisive, the French emperor placed a villa at his disposal near Trieste, where silk-worm

* These words were uttered at a time when the pythogenic theory was more in favor than it is now.

culture had been carried on for some time at a loss. The success here is described as marvelous; the sale of cocoons giving to the villa a net profit of twenty-six millions of francs.* From the imperial villa M. Pasteur addressed to me a letter, a portion of which I have already published. It may perhaps prove usefully suggestive to our Indian or colonial authorities if I reproduce it here:

"Permettez-moi de terminer ces quelques lignes que je dois dicter, vaincu que je suis par la maladie, en vous faisant observer que vous rendriez service aux colonies de la Grande-Bretagne en répandant la connaissance de ce livre, et des principes que j'établis touchant la maladie des vers à soie. Beaucoup de ces colonies pourraient cultiver le mûrier avec succès, et, en jetant les yeux sur mon ouvrage, vous vous convaincrez aisément qu'il est facile aujourd'hui, nonseulement d'éloigner la maladie régnante, mais en outre de donner aux récoltes de la soie une prospérité qu'elles n'ont jamais eue."

The studies on wine prepare us for the "Studies on Beer," which followed the investigation of silk-worm diseases. The sourness, putridity, and other maladies of beer Pasteur traced to special "ferments of disease," of a totally different form, and therefore easily distinguished from the true *torula* or yeast-plant. Many mysteries of our breweries were cleared up by this inquiry. Without knowing the cause, the brewer not unfrequently incurred heavy losses through the use of bad yeast. Five minutes' examination with the microscope would have revealed to him the cause of the badness, and prevented him from using the yeast. He would have seen the true *torula* overpowered by foreign intruders. The microscope is, I believe, now everywhere in use. At Burton-on-Trent its aid was very soon invoked. At the conclusion of his studies on beer M. Pasteur came to London, where I had the pleasure of conversing with him. Crippled by paralysis, bowed down by the sufferings of France, and anxious about his family at a troubled and an uncertain time, he appeared low in health and depressed in spirits. His robust appearance when he visited London, on the occasion of the Edinburgh Anniversary, was in marked and pleasing contrast with my memory of his aspect at the time to which I have referred.

While these researches were going on, the germ theory of infectious disease was noised abroad. The researches of Pasteur were frequently referred to as bearing upon the subject, though Pasteur himself kept clear for a long time of this special field of inquiry. He was not a physician, and he did not feel called upon to trench upon the physician's domain. And now I would beg of him to correct me if, at this point of the introduction, I should be betrayed into any statement that is not strictly correct.

In 1876 the eminent microscopist, Professor Cohn, of Breslau, was in London, and he then handed me a number of his "Beiträge," con-

* The work on "Diseases of Silk-worms" was dedicated to the Empress of the French.

taining a memoir by Dr. Koch on splenic fever (*Milzbrand, Charbon*, malignant pustule), which seemed to me to mark an epoch in the history of this formidable disease. With admirable patience, skill, and penetration, Koch followed up the life-history of *bacillus anthracis*, the contagium of this fever. At the time here referred to he was a young physician, holding a small appointment in the neighborhood of Breslau, and it was easy to predict, as I predicted at the time, that he would soon find himself in a higher position. When I next heard of him he was head of the Imperial Sanitary Institute of Berlin. Koch's recent history is pretty well known in England, while his appreciation by the German Government is shown by the rewards and honors lately conferred upon him.

Koch was not the discoverer of the parasite of splenic fever. Davaine and Rayer, in 1850, had observed the little microscopic rods in the blood of animals which had died of splenic fever. But they were quite unconscious of the significance of their observation, and for thirteen years, as M. Radot informs us, strangely let the matter drop. In 1863 Davaine's attention was again directed to the subject by the researches of Pasteur, and he then pronounced the parasite to be the cause of the fever. He was opposed by some of his fellow-countrymen ; long discussions followed, and a second period of thirteen years, ending with the publication of Koch's paper, elapsed, before M. Pasteur took up the question. I always, indeed, assumed that from the paper of the learned German came the impulse toward a line of inquiry in which M. Pasteur has achieved such splendid results. Things presenting themselves thus to my mind, M. Radot will, I trust, forgive me if say that it was with very great regret that I perused the disparaging references to Dr. Koch which occur in the chapter on splenic fever.

After Koch's investigation, no doubt could be entertained of the parasitic origin of this disease. It completely cleared up the perplexity previously existing as to the two forms—the one fugitive, the other permanent—in which the contagion presented itself. I may say that it was on the conversion of the permanent hardy form into the fugitive and sensitive one, in the case of *bacillus subtilis* and other organisms, that the method of sterilizing by "discontinuous heating" introduced by me in February, 1877, was founded. The difference between an organism and its spores, in point of durability, had not escaped the penetration of Pasteur. This difference Koch showed to be of paramount inportance in splenic fever. He, moreover, proved that while mice and Guinea-pigs were infallibly killed by the parasite, birds were able to defy it.

And here we come upon what may be called a hand-specimen of the genius of Pasteur, which strikingly illustrates its quality. Why should birds enjoy the immunity established by the experiments of Koch? Here is the answer. The temperature which prohibits the

multiplication of *bacillus anthracis* in infusions is 44° C. (111° Fahr.). The temperature of the blood of birds is from 41° to 42° Fahr. It is therefore close to the prohibitory temperature. But then the blood-globules of a living fowl are sure to offer a certain resistance to any attempt to deprive them of their oxygen—a resistance not experienced in an infusion. May not this resistance, added to the high temperature of the fowl, suffice to place it beyond the power of the parasite? Experiment alone could answer this question, and Pasteur made the experiment. By placing its feet in cold water he lowered the temperature of a fowl to 37° or 38° Fahr. He inoculated the fowl, thus chilled, with the splenic-fever parasite, and in twenty-four hours it was dead. The argument was clinched by inoculating a chilled fowl, permitting the fever to come to a head, and then removing the fowl, wrapped in cotton-wool, to a chamber with a temperature of 35° Fahr. The strength of the patient returned as the career of the parasite was brought to an end, and in a few hours health was restored. The sharpness of the reasoning here is only equaled by the conclusiveness of the experiment, which is full of suggestiveness as regards the treat ment of fevers in man.

Pasteur had little difficulty in establishing the parasitic origin of fowl-cholera; indeed, the parasite had been observed by others before him. But, by his successive cultivations, he rendered the solution sure. His next step will remain forever memorable in the history of medicine. I allude to what he calls "virus attenuation." And here it may be well to throw out a few remarks in advance. When a tree, or a bundle of wheat or barley straw, is burned, a certain amount of mineral matter remains in the ashes—extremely small in comparison with the bulk of the tree or of the straw, but absolutely essential to its growth. In a soil lacking, or exhausted of, the necessary mineral constituents, the tree can not live, the crop can not grow. Now, contagia are living things, which demand certain elements of life just as inexorably as trees, or wheat, or barley; and it is not difficult to see that a crop of a given parasite may so far use up a constituent existing in small quantities in the body, but essential to the growth of the parasite, as to render the body unfit for the production of a second crop. The soil is exhausted, and, until the lost constituent is restored, the body is protected from any further attack of the same disorder. Such an explanation of non-recurrent diseases naturally presents itself to a thorough believer in the germ theory, and such was the solution which, in reply to a question, I ventured to offer nearly fifteen years ago to an eminent London physician. To exhaust a soil, however, a parasite less vigorous and destructive than the really virulent one may suffice; and, if, after having by means of a feebler organism exhausted the soil, without fatal result, the most highly virulent parasite be introduced into the system, it will prove powerless. This, in the language of the germ theory, is the whole secret of vaccination.

The general problem, of which Jenner's discovery was a particular case, has been grasped by Pasteur, in a manner, and with results, which five short years ago were simply unimaginable. How much "accident" had to do with shaping the course of his inquiries I know not. A mind like his resembles a photographic plate, which is ready to accept and develop luminous impressions, sought and unsought. In the chapter on fowl-cholera is described how Pasteur first obtained his attenuated virus. By successive cultivations of the parasite he showed that, after it had been a hundred times reproduced, it continued to be as virulent as at first. One necessary condition was, however, to be observed. It was essential that the cultures should rapidly succeed each other—that the organism, before its transference to a fresh cultivating liquid, should not be left long in contact with air. When exposed to air for a considerable time the virus becomes so enfeebled that when fowls are inoculated with it, though they sicken for a time, they do not die. But this "attenuated" virus, which M. Radot justly calls "benign," constitutes a sure protection against the virulent virus. It so exhausts the soil that the really fatal contagium fails to find there the elements necessary to its reproduction and multiplication.

Pasteur affirms that it is the oxygen of the air which, by lengthened contact, weakens the virus and converts it into a true vaccine. He has also weakened it by transmission through various animals. It was this form of attenuation that was brought into play in the case of Jenner.

The secret of attenuation had thus become an open one to Pasteur. He laid hold of the murderous virus of splenic fever, and succeeded in rendering it, not only harmless to life, but a sure protection against the virus in its most concentrated form. No man, in my opinion, can work at these subjects so rapidly as Pasteur without falling into errors of detail. But this may occur while his main position remains impregnable. Such a result, for example, as that obtained in presence of so many witnesses at Melun must surely remain an ever-memorable conquest of science. Having prepared his attenuated virus, and proved, by laboratory experiments, its efficacy as a protective vaccine, Pasteur accepted an invitation, from the President of the Society of Agriculture at Melun, to make a public experiment on what might be called an agricultural scale. This act of Pasteur's is, perhaps, the boldest thing recorded in this book. It naturally caused anxiety among his colleagues of the Academy, who feared that he had been rash in closing with the proposal of the president.

But the experiment was made. A flock of sheep was divided into two groups, the members of one group being all vaccinated with the attenuated virus, while those of the other group were left unvaccinated. A number of cows were also subjected to a precisely similar treatment. Fourteen days afterward all the sheep and all the cows, vaccinated and unvaccinated, were inoculated with a very virulent

virus; and three days subsequently more than two hundred persons assembled to witness the result. The "shout of admiration," mentioned by M. Radot, was a natural outburst under the circumstances. Of twenty-five sheep which had not been protected by vaccination, twenty-one were already dead, and the remaining ones were dying. The twenty-five vaccinated sheep, on the contrary, were "in full health and gayety." In the unvaccinated cows intense fever was produced, while the prostration was so great that they were unable to eat. Tumors were also formed at the points of inoculation. In the vaccinated cows no tumors were formed; they exhibited no fever, nor even an elevation of temperature, while their power of feeding was unimpaired. No wonder that "breeders of cattle overwhelmed Pasteur with applications for vaccine." At the end of 1881 close upon thirty-four thousand animals had been vaccinated, while the number rose in 1883 to nearly five hundred thousand.

M. Pasteur is now exactly sixty-two years of age; but his energy is unabated. At the end of this volume we are informed that he has already taken up and examined with success, as far as his experiments have reached, the terrible and mysterious disease of rabies or hydrophobia. Those who hold all communicable diseases to be of parasitic origin, include, of course, rabies among the number of those produced and propagated by a living contagium. From his first contact with the disease Pasteur showed his accustomed penetration. If we see a man mad, we at once refer his madness to the state of his brain. It is somewhat singular that in the face of this fact the virus of a mad dog should be referred to the animal's saliva. The saliva is, no doubt, infected, but Pasteur soon proved the real seat and empire of the disorder to be the nervous system.

The parasite of rabies had not been securely isolated when M. Radot finished his task. But last May, at the instance of M. Pasteur, a commission was appointed, by the Minister of Public Instruction in France, to examine and report upon the results which he had up to that time obtained. A preliminary report, issued to appease public impatience, reached me before I quitted Switzerland this year. It inspires the sure and certain hope that, as regards the attenuation of the rabic virus, and the rendering of an animal, by inoculation, proof against attack, the success of M. Pasteur is assured. The commission, though hitherto extremely active, is far from the end of its labors; but the results obtained so far may be thus summed up:

Of six dogs unprotected by vaccination, three succumbed to the bites of a dog in a furious state of madness.

Of eight unvaccinated dogs, six succumbed to the intravenous inoculation of rabic matter.

Of five unvaccinated dogs, all succumbed to inoculation, by trepanning, of the brain.

Finally, of three-and-twenty vaccinated dogs, not one was attacked

with the disease subsequent to inoculation with the most potent virus.

Surely results such as those recorded in this book are calculated, not only to arouse public interest, but public hope and wonder. Never before, during the long period of its history, did a day like the present dawn upon the science and art of medicine. Indeed, previous to the discoveries of recent times, medicine was not a science, but a collection of empirical rules dependent for their interpretation and application upon the sagacity of the physician. How does England stand in relation to the great work now going on around her? She is, and must be, behindhand. Scientific chauvinism is not beautiful in my eyes. Still, one can hardly see, without deprecation and protest, the English investigator handicapped in so great a race by short-sighted and mischievous legislation.

A great scientific theory has never been accepted without opposition. The theory of gravitation, the theory of undulation, the theory of evolution, the dynamical theory of heat—all had to push their way through conflict to victory. And so it has been with the germ theory of communicable diseases. Some outlying members of the medical profession dispute it still. I am told they even dispute the communicability of cholera. Such must always be the course of things, as long as men are endowed with different degrees of insight. Where the mind of genius discerns the distant truth, which it pursues, the mind not so gifted often discerns nothing but the extravagance, which it avoids. Names, not yet forgotten, could be given to illustrate these two classes of minds. As representative of the first class, I would name a man whom I have often named before, who, basing himself in great part on the researches of Pasteur, fought, in England, the battle of the germ theory with persistent valor, but whose labors broke him down before he saw the triumph which he *fore*saw completed. Many of my medical friends will understand that I allude here to the late Dr. William Budd, of Bristol.

The task expected of me is now accomplished, and the reader is here presented with a record in which the verities of science are endowed with the interest of romance.

TRAINING IN ETHICAL SCIENCE.

By H. H. CURTIS.

THE importance of education in the duties of life is recognized in a greater or less degree by all. People differ widely as to absolute standards of right and wrong, and as to the foundation or source of such standards, but all concede by daily acts, as well as by avowed opinions, the necessity of some kind of moral training. Every parent

who restrains his child from the commission of a wrongful act, or approves its conduct when praiseworthy, does so in recognition of the importance of moral education. Every individual who uses his influence to keep others from evil associations, or who commends a noble or kindly act, thus manifests his appreciation of the necessity of moral or ethical culture. However undefined may be the limits, however imperfectly understood may be the sources of the laws of duty, it is continually forced upon the attention of every thoughtful person that a proper observance of these laws is of vast importance to mankind. The happiness of man—the great legitimate end of human effort—depends so largely upon the recognition and adoption of high standards of duty, that nothing can exceed in importance the cultivation of the science of duty and the spirit of right action.

The human race is still far from a condition of ideal perfection; man has not as yet reached his highest estate. In the words of Tennyson:

> "A monstrous eft was of old the Lord and Master of Earth;
> For him did his high sun shine, and his river billowing ran,
> And he felt himself in his force to be Nature's crowning race.
> As nine months go to the shaping an infant ripe for its birth,
> So many a million of ages have gone to the making of man;
> He now is first, but is he the last? is he not too base?"

The world is full of want and misery; the strong trample upon the rights of the weak, the cunning take advantage of the unwary, the impulsive and the irresolute are lured on to lives of vice and crime. From every quarter there arise appeals for help, for strength to overcome temptation, for power to resist oppression, for succor in distress. Beyond all these things, as we ascend in the scale of ethical development, there exists a demand for that recognition of the rights of others, that spirit of fellowship and true manhood which shall abridge and overcome the passion of grasping selfishness. How prevalent is the desire for that ostentatious splendor and luxurious ease which too often represent the fruits of many a hard and narrow life of penury and ill-requited toil!

We live in an age of observation, of investigation, of a study of Nature's laws and methods. Nor is the advance of the physical sciences more marked than that of the useful arts. Do not the problems of *life* also demand attention? Is a knowledge of the laws of the physical universe so all-important that no time shall be spared, no thought devoted to acquiring further knowledge of the laws of duty? Every thoughtful observer must admit that *the great governing factor in the problem of the advancement of human happiness is the conduct of man toward his fellow-man.* Immeasurable in importance is the fostering of a spirit of true devotion to duty. There is no loftier ambition, no nobler work, no higher ideal of life, than the promotion of the virtue, goodness, and happiness of mankind.

What are the means by which these ends shall be accomplished? Shall we rely solely upon our supposed consciousness of what is right and what is wrong, and let moral teaching consist simply of appeals for obedience to the dictates of conscience? That which is termed conscience is, in a large degree at least, a matter of inherited tendencies, education, and intellectual development, and varies with the individual, his surroundings, and the age in which he lives.

That which seems right to the mind of one man often seems wrong when presented to the intelligent judgment of other men. The conscience of the average member of a civilized community differs widely from the conscience of the average member of a savage tribe. To the American Indian, revenge is a virtue; to the Quaker, revenge is a crime. To Gautama, to Jesus of Nazareth, and to their ascetic disciples, the total rejection of personal interest or advancement—absolute unselfishness and self-abnegation, unlimited benevolence, and an entire absence of the desire or habit of self-protection—were the greatest virtues and most obligatory duties.

On the other hand, the constitutions of all civilized governments, whether written or unwritten, the principles of the civil as well as those of the common law, and the teachings of wise men of ancient and of modern times, recognize as a duty the protection of individual or selfish interests. They recognize as just and necessary the restraint and punishment of wrong-doers, and the protection of the rights and interests of the individual in person and property. Educated to look upon these and kindred principles as embodying correct rules of conduct, we view with approval the resistance of oppression and injustice, and even the spirit which resents and punishes insult.

There can be no doubt that these are conflicting views of duty, but both extremes have been honestly maintained, and still are in some degree. It hardly admits of a doubt that men of pure motives and good intentions have committed acts of cruelty and inhumanity in the belief that they were simply discharging duties—perchance religious duties.

All these things point to the fallibility of human judgment regarding standards of duty, and the imperfect development of ideas of right and wrong. They furnish no excuse, however, for drifting through life without an attempt to investigate or discover the principles of the science of duty, or for neglecting to govern our actions by those principles, so far as we may be able to recognize them.

With the waning and crumbling of a faith in any books or records as containing absolute or inspired standards of duty, the study of the science and data of ethics should, it would seem, become one of greater interest and attention than ever before.

Whether we regard the ability to distinguish between right and wrong conduct as in a great degree inherent in the human mind, or as having arisen in the course of the evolution of the race, as a sense

of that which is conducive to the happiness of man, it is certainly a faculty or sense which is largely developed by educational training and example. Without this, it surely can not be relied upon as an unerring guide in all the problems of life. Man does not possess a power to distinguish between right and wrong action which rises superior to the need of cultivation. For such culture teachers are required, and the great necessity of united action is apparent. If associated action in the shape of schools of moral or ethical training, and agencies for charitable work—the fruit of such training—are demanded, we are confronted with the question of what their nature should be, and how far the want is already supplied. If the means now provided for these purposes are as good as any that can be devised, and if they are suited to the needs and uses of all, it were idle to supply other agencies.

Foremost, perhaps, among the agencies now existing, are the churches. According to the theories adopted and taught by the various religious organizations which are collectively known as Christian, the cultivation of ethical truths, or, in other words, the recognition and adoption of high standards of duty, is regarded as but a part of a religious system founded upon the revealed will of a Divine Being.

To those who accept so-called revelation as infallible truth, the rules of conduct or systems of ethics recognized in their Scriptures furnish, in theory, and so far as they can be harmonized, final and absolute standards of human duty. To them, theoretically at least, right or wrong action is such simply by reason of its adherence to or departure from certain standards of duty recognized in their sacred writings.

To the individual who looks upon the sacred books of Jew and Christian, of Mohammedan and Buddhist, as alike the works of men—men of varying degrees of mental and moral development—the idea of accepting their conclusions as *final* upon the great problems of the duty of man seems narrow and illogical. To him the absolute acceptance of these standards as final, however high he may concede some of them to be, is to place a limit upon moral development and to deny that

> "The thoughts of men are widened with the process of the suns."

But it does not follow, even from the point of view of the agnostic, that there is nothing of value in the ethical teachings of the orthodox Christian churches. Most if not all religions have recognized, and in some sense demanded, the adoption of certain exalted standards of duty, and in this particular the Christian religion stands deservedly high among the great religions of the world. Charity, kindness, and love, are not less beautiful because recognized as such by the churches. A true statement of the duty of man to his fellow-man does not become false because attributed to a Divine Being, or declared to be inspired. It does not become *false* even when the observance of the duty is

sought to be enforced by an appeal to selfish interests—by the promise of reward or the threat of punishment in a life of which we know not.

Nor is the value of the *moral* teaching of the churches to be ignored merely because they insist that it is the duty of all to accept and adopt their *theological* teachings—their conception of the infinite and unknown, with its attendant dogmas and "cramping bounds of creed."

The crude and sometimes wholly indefensible theories of right and wrong which are recognized and treated as of divine authority in portions of the Scriptures do not furnish a sufficient reason for an unqualified condemnation of the ethical teachings of the churches. It is in general only in some strained theory—rarely in a practical application to the duties of life—that the most extreme and ultra standards of duty recognized in the writings which are collectively known as the Bible are inculcated, or even defended, inside the churches. Even those men whose mistaken zeal and religious bias lead them to attempt a defense of all the varying and inconsistent standards of duty recognized or promulgated by the many authors of the writings which make up our Bible, do so rather in theory than in fact. In their daily life, or practical advice to others, they adopt neither the standard of implacable and indiscriminating revenge and cruelty on the one hand, nor that of absolute self-abasement and meek submission to insult and injury on the other, which are alternately represented as attributes of the Divine character by the respective authors of these so-called sacred writings.

Without stopping here to discuss the objectionable features of a system of ethical training or education which has its nominal foundation in the supposed fiat of a Divine Intelligence, and which in theory necessarily precludes the possibility of the development of higher standards, it may be conceded that such education in morals is better than none. The value of such education is not wholly counterbalanced by the evil of its constant appeal to the selfish interests by promises of personal reward or threats of punishment, rather than to the nobler sentiments of the mind. Conceding the moral education of the churches to be imperfect in theory, in the manner in which it is imparted, and the means by which it is sought to be enforced, it nevertheless contains elements of good to those who can receive it.

The believer of course finds in the ethical teachings of his church a deeper and fuller moral education than they impart to others. He can at least give due weight to their real merits, and they are to him authoritative in a greater or less degree—the degree being dependent upon his faith in their divine origin. From long association of ideas and the influence of early education, the attendant *theological* teachings do not suggest to him that sense of incongruity and inconsistency which they present to others.

But how far is the moral education furnished by the Church suited to the needs of those who are compelled to reject its theological dogmas concerning the unknown, and to regard its standards of duty as

those of fallible men only? Does it furnish to the earnest and fearless seeker for moral truth an undeviating path to the object of his search? Is he not constantly invited to depart from his course on journeys through the pathless wastes of theological speculation, where each man thinks his diverging creed marks the true highway to heaven?

There are various reasons why the earnest seeker for truth who is without religious belief can not feel content with the Church as a teacher of moral duty. The energy, the time, the money which should be devoted to building up character, to a recognition of the duties of man to his fellow-man, to the relief of the afflicted, to an intelligent dealing with the great problems of this life—he sees devoted largely to building up, promulgating, or seeking excuse for dogmas and theories from which his intelligence revolts. With want and suffering appealing for relief, with ignorance demanding enlightenment, with a thousand duties at our doors which scarcely receive a passing notice, we are asked to follow these blind teachers of the blind away from the things of this world, and to enjoy with them their irrational conception of what is to us the unknown—perhaps the unknowable.

Of what value is a sermon on the duty and efficacy of prayer, to one who looks upon the question of the existence of a Divine Being as an insoluble problem? Of what use or benefit to him is a discourse on the nature of the Trinity, or the theory of the atonement?

The rationalist is compelled to look upon the books which make up the Bible as simply the work of fallible men, of varying degrees of intelligence, and representing the thought of widely differing periods of human development. To him, what is there of interest in attempts to reconcile their contradictions and inconsistencies—attempts to establish the untenable theory that they embody and set forth the plan and design of an all-wise Author of the universe?

If the rationalist would support and uphold the *ethical* school of the Church, he is in a measure also supporting and upholding *theological* ideas which are to him in the last degree unreasonable and improbable. His money pays misguided men for teaching the ignorant of earth that the all-foreseeing and merciful Author of all things would doom his creatures to suffer untold agony throughout eternity for the sins and mistakes of a short life, or for using the reason with which he has endowed them! Where one dollar goes to relieve want, or build up character, two go to build up church or creed. The relief of the widow and the fatherless is thought a matter of less importance than acquainting the heathen with the theological dogmas of the Christian Church.

Of course the church-going and church-supporting rationalist must expect to be continually reminded of the culpability of his unbelief, which, so far as he can judge, arises simply from an exercise of his reasoning faculties, and not from any wrongful intention. He becomes wearied and disheartened by the want of consideration shown for the

duties of this life, and the undue prominence given to a supposed preparation for an alleged future life, of which he has no evidence and can form no conception.

But though the Church fails to furnish adequate ethical training to those who can not accept its theological teachings, some kind of moral education is necessary if we would have true moral development. While much can be done in the home circle in teaching the rudiments of the science of duty—the beauty of love and charity and other attributes of noble character—this is not alone sufficient to meet the demand which should exist for true ethical culture. Teachers are needed. The complicated interests which surround most of the great social and moral problems demand the most careful and patient study, and only he who has brought to these tasks the forces of a well-trained mind can suggest the true means of relief from conditions which all may recognize as deplorable. The value of association with a broad and generous mind—a mind filled with high and pure conceptions of duty—a mind which ever presents and holds before us high and noble ideals, can not well be overestimated.

The time may come when the Church will so far outgrow the myths, the dogmas, and the beliefs with which it now struggles that there will be room within it for all who would earnestly unite in efforts to better the condition of man, and to diffuse a knowledge of those principles which lie at the foundation of human happiness. There is, indeed, a progress of thought in the Church far broader and deeper than any actual modifications of written creeds would indicate. We will not pause to inquire as to what class of thinkers is chiefly entitled to the credit for this progress. This rapid development in the direction of individual freedom of thought may give us at length a church—by whatever name it may be designated—where the only creed held binding will be the creed of love, the only devotion essential to true fellowship a devotion to truth and duty.

Meanwhile, though there are signs of progress, and noble exceptions in the few societies for ethical culture now existing, and in similar organizations, it is evident that the demand for ethical progress outside the Church has not as yet culminated in any general constructive effort either in the direction of improving the condition of the weak, the needy, and the suffering, or in the cultivation of the science of duty.

It is in one sense an unfortunate circumstance that most rationalists are persons of very independent habits of thought. Their work in the past has been necessarily and perhaps almost too largely one of iconoclasm. The exposure of shams, the demolition of creed and dogma, the unveiling of myth and traditional faith based upon foundations which have slowly crumbled away in the light of increasing intelligence, have thus far largely occupied the attention of the rationalist. The men who have done this work are not of a nature which

bids them cling together for mutual support and sympathy, and as a whole they have hardly the characteristics which would qualify them for united constructive effort. Nevertheless, association is needed. A comparison of views, each individual reaping the benefit of the thought of his co-workers, is of the highest value. Without associated action but little enthusiasm can be expected, and enthusiasm is all-important in carrying forward any good work. The employment of earnest and competent teachers and leaders in thought is practicable only through united action. For charitable work—the relief of want, the alleviation of suffering, the furnishing of employment, the assistance which helps others to help themselves—associated and united effort is well-nigh indispensable. And in earnest exertions to improve the condition and add to the happiness of our fellows, may be found the best and highest ethical culture, giving to those who engage in the work a new conception as it were of the higher duties and nobler life of man.

A VERY OLD MASTER.

THE work of art which lies before me is old, unquestionably old; a good deal older, in fact, than Archbishop Usher (who invented all out of his own archiepiscopal head the date commonly assigned for the creation of the world) would by any means have been ready to admit. It is a bas-relief by an old master, considerably more antique in origin than the most archaic gem or intaglio in the Museo Borbonico at Naples, the mildly decorous Louvre in Paris, or the eminently respectable British Museum, which is the glory of our own smoky London in the spectacled eyes of German professors, all put together. When Assyrian sculptors carved in fresh white alabaster the flowing curls of Sennacherib's hair, just like a modern coachman's wig, this work of primæval art was already hoary with the rime of ages. When Memphian artists were busy in the morning twilight of time with the towering coiffure of Rameses or Sesostris, this far more ancient relic of plastic handicraft was lying, already fossil and forgotten, beneath the concreted floor of a cave in the Dordogne. If we were to divide the period for which we possess authentic records of man's abode upon this oblate spheroid into ten epochs—an epoch being a good, high-sounding word which doesn't commit one to any definite chronology in particular—then it is probable that all known art, from the Egyptian onward, would fall into the tenth of the epochs thus loosely demarkated, while my old French bas-relief would fall into the first. To put the date quite succinctly, I should say it was most likely about 244,000 years before the creation of Adam according to Usher.

The work of the old master is lightly incised on reindeer-horn, and represents two horses, of a very early and heavy type, following

one another, with heads stretched forward, as if sniffing the air suspiciously in search of enemies. The horses would certainly excite unfavorable comment at Newmarket. Their "points" are undoubtedly coarse and clumsy: their heads are big, thick, stupid, and ungainly; their manes are bushy and ill-defined; their legs are distinctly feeble and spindle-shaped; their tails more closely resemble the tail of the domestic pig than that of the noble animal beloved with a love passing the love of women by the English aristocracy. Nevertheless, there is little (if any) reason to doubt that my very old master did, on the whole, accurately represent the ancestral steed of his own exceedingly remote period. There were once horses even as is the horse of the prehistoric Dordonian artist. Such clumsy, big-headed brutes, dun in hue and striped down the back like modern donkeys, did actually once roam over the low plains where Paris now stands, and browse off lush grass and tall water-plants around the quays of Bordeaux and Lyons. Not only do the bones of the contemporary horses, dug up in caves, prove this, but quite recently the Russian traveler Prjevalsky (whose name is so much easier to spell than to pronounce) has discovered a similar living horse, which drags on an obscure existence somewhere in the high table-lands of Central Asia. Prjevalsky's horse (you see, as I have only to write the word, without uttering it, I don't mind how often or how intrepidly I use it) is so singularly like the clumsy brutes that sat, or rather stood, for their portraits to my old master, that we can't do better than begin by describing him *in propria persona.*

The horse family of the present day is divided, like most other families, into two factions, which may be described for variety's sake as those of the true horses and the donkeys, these latter including also the zebras, quaggas, and various other unfamiliar creatures whose names, in very choice Latin, are only known to the more diligent visitors at the Sunday Zoo. Now everybody must have noticed that the chief broad distinction between these two great groups consists in the feathering of the tail. The domestic donkey, with his near congeners, the zebra and co., have smooth, short-haired tails, ending in a single bunch or fly-whisk of long hairs collected together in a tufted bundle at the extreme tip. The horse, on the other hand, besides having horny patches or callosities on both fore and hind legs, while the donkeys have them on the fore-legs only, has a hairy tail, in which the long hairs are almost equally distributed from top to bottom, thus giving it its peculiarly bushy and brushy appearance. But Prjevalsky's horse, as one would naturally expect from an early intermediate form, stands half-way in this respect between the two groups, and acts the thankless part of a family mediator; for it has most of its long tail-hairs collected in a final flourish, like the donkey, but several of them spring from the middle distance, as in the genuine Arab, though never from the very top, thus showing an approach to the true horsey habit without actually attaining that final pinnacle of equine glory. So far as one

can make out from the somewhat rude handicraft of my prehistoric Phidias, the horse of the quaternary epoch had much the same caudal peculiarity; his tail was bushy, but only in the lower half. He was still in the intermediate stage between horse and donkey, a natural mule still struggling up aspiringly toward perfect horsehood. In all other matters the two creatures—the cave-man's horse and Prjevalsky's—closely agree. Both display large heads, thick necks, coarse manes, and a general disregard of "points" which would strike disgust and dismay into the stout breasts of Messrs. Tattersall. In fact, over a T. Y. C. it may be confidently asserted, in the pure Saxon of the sporting papers, that Prjevalsky's and the cave-man's lot wouldn't be in it. Nevertheless, a candid critic would be forced to admit that, in spite of clumsiness, they both mean staying.

So much for the two sitters; now let us turn to the artist who sketched them. Who was he, and when did he live? Well, his name, like that of many other old masters, is quite unknown to us; but what does that matter, so long as his work itself lives and survives? Like the Comtists he has managed to obtain objective immortality. The work, after all, is for the most part all we ever have to go upon. "I have my own theory about the authorship of the Iliad and Odyssey," said Lewis Carroll (of "Alice in Wonderland") once in Christ Church common-room; "it is that they weren't really written by Homer, but by another person of the same name." There you have the Iliad in a nutshell as regards the authenticity of great works. All we know about the supposed Homer (if anything) is that he was the reputed author of the two unapproachable Greek epics; and all we know directly about my old master, viewed personally, is that he once carved with a rude flint flake on a fragment of reindeer-horn these two clumsy prehistoric horses. Yet by putting two and two together we can make, not four, as might be naturally expected, but a fairly connected history of the old master himself and what Mr. Herbert Spencer would no doubt playfully term his "environment."

The work of art was dug up from under the firm concreted floor of a cave in the Dordogne. That cave was once inhabited by the nameless artist himself, his wife, and family. It had been previously tenanted by various other early families, as well as by bears who seem to lived there in the intervals between the different human occupiers. Probably the bears ejected the men, and the men in turn ejected the bears, by the summary process of eating one another up. In any case the freehold of the cave was at last settled upon our early French artist. But the date of his occupancy is by no means recent; for since he lived there the long cold spell known as the Great Ice Age, or Glacial Epoch, has swept over the whole of Northern Europe, and swept before it the shivering descendants of my poor prehistoric old master. Now, how long ago was the Great Ice Age? As a rule, if you ask a geologist for a definite date, you will find him very chary of

giving you a distinct answer. He knows that the chalk is older than the London clay, and the oölite than the chalk, and the red marl than the oölite; and he knows also that each of them took a very long time indeed to lay down, but exactly how long he has no notion. If you say to him, "Is it a million years since the chalk was deposited?" he will answer, like the old lady of Prague, whose ideas were excessively vague, "Perhaps." If you suggest five millions, he will answer oracularly once more, "Perhaps"; and if, you go on to twenty millions, "Perhaps," with a broad smile, is still the only confession of faith that torture will wring out of him. But in the matter of the Glacial Epoch, a comparatively late and almost historical event, geologists have broken through their usual reserve on this chronological question, and condescended to give us a numerical determination. And here is how Dr. Croll gets at it.

Every now and again, geological evidence goes to show us, a long cold spell occurs in the northern or southern hemisphere. During these long cold spells the ice-cap at the poles increases largely, till it spreads over a great part of what are now the temperate regions of the globe, and makes ice a mere drug in the market as far south as Covent Garden or the Halles at Paris. During the greatest extension of this ice-sheet in the last glacial epoch, in fact, all England except a small southwestern corner (about Torquay and Bournemouth) was completely covered by one enormous mass of glaciers, as is still the case with almost the whole of Greenland. The ice-sheet, grinding slowly over the hills and rocks, smoothed, and polished, and striated their surfaces in many places till they resembled the *roches moutonnées* similarly ground down in our own day by the moving ice-rivers of Chamouni and Grindelwald. Now, since these great glaciations have occurred at various intervals in the world's past history, they must depend upon some frequently recurring cause. Such a cause, therefore, Dr. Croll began ingeniously to hunt about for.

He found it at last in the eccentricity of the earth's orbit. This world of ours, though usually steady enough in its movements, is at times decidedly eccentric. Not that I mean to impute to our old and exceedingly respectable planet any occasional aberrations of intellect, or still less of morals (such as might be expected from Mars and Venus); the word is here to be accepted strictly in its scientific or Pickwickian sense as implying merely an irregularity of movement, a slight wobbling out of the established path, a deviation from exact circularity. Owing to a combination of astronomical revolutions, the precession of the equinoxes and the motion of the aphelion (I am not going to explain them here; the names alone will be quite sufficient for most people; they will take the rest on trust)—owing to the combination of these profoundly interesting causes, I say, there occur certain periods in the world's life when for a very long time together (10,500 years, to be quite precise) the northern hemisphere is warmer than the south-

ern, or *vice versa*. Now, Dr. Croll has calculated that about 250,000 years ago this eccentricity of the earth's orbit was at its highest, so that a cycle of recurring cold and warm epochs in either hemisphere alternately then set in; and such cold spells it was that produced the Great Ice Age in Northern Europe. They went on till about 80,000 years ago, when they stopped short for the present, leaving the climate of Britain and the neighboring continent with its existing inconvenient Laodicean temperature. And, as there are good reasons for believing that my old master and his contemporaries lived just before the greatest cold of the Glacial Epoch, and that his immediate descendants, with the animals on which they feasted, were driven out of Europe, or out of existence, by the slow approach of the enormous ice-sheet, we may, I think, fairly conclude that his date was somewhere about B. C. 248,000. In any case we must at least admit, with Mr. Andrew Lang, the laureate of the twenty-five thousandth century, that

> "He lived in the long, long agoes;
> 'Twas the manner of primitive man."

The old master, then, carved his bas-relief in pre-glacial Europe, just at the moment before the temporary extinction of his race in France by the coming on of the Great Ice Age. We can infer this fact from the character of the fauna by which he was surrounded, a fauna in which species of cold and warm climates are at times quite capriciously intermingled. We get the reindeer and the mammoth side by side with the hippopotamus and the hyena; we find the chilly cave-bear and the Norway lemming, the musk-sheep and the Arctic fox in the same deposits with the lion and the lynx, the leopard and the rhinoceros. The fact is, as Mr. Alfred Russel Wallace has pointed out, we live to-day in a zoölogically impoverished world, from which all the largest, fiercest, and most remarkable animals have lately been weeded out. And it was in all probability the coming on of the Ice Age that did the weeding. Our Zoo can boast no mammoth and no mastodon. The saber-toothed lion has gone the way of all flesh; the deinotherium and the colossal ruminants of the Pliocene Age no longer browse beside the banks of Seine. But our old master saw the last of some at least among those gigantic quadrupeds; it was his hand, or that of one among his fellows, that scratched the famous mammoth etching on the ivory of La Madelaine, and carved the figure of the extinct cave-bear on the reindeer-horn ornaments of Laugerie Basse. Probably, therefore, he lived in the period immediately preceding the Great Ice Age, or else perhaps in one of the warm interglacial spells with which the long secular winter of the northern hemisphere was then from time to time agreeably diversified.

And what did the old master himself look like? Well, painters have always been fond of reproducing their own lineaments. Have we not the familiar young Raphael painted by himself, and the Rembrandt, and the Titian, and the Rubens, and a hundred other self-

drawn portraits, all flattering and all famous? Even so primitive man has drawn himself many times over, not indeed on this particular piece of reindeer-horn, but on several other media to be seen elsewhere, in the original or in good copies. One of the best portraits is that discovered in the old cave at Laugerie Basse by M. Élie Massénat, where a very early pre-glacial man is represented in the act of hunting an aurochs, at which he is casting a flint-tipped javelin. In this as in all other pictures of the same epoch I regret to say that the ancient hunter is represented in the costume of Adam before the fall. Our old master's studies, in fact, are all in the nude. Primitive man was evidently unacquainted as yet with the use of clothing, though primitive woman, while still unclad, had already learned how to heighten her natural charms by the simple addition of a necklace and bracelets. Indeed, though dresses were still wholly unknown, rouge was even then extremely fashionable among French ladies, and lumps of the ruddle with which primitive woman made herself beautiful forever are now to be discovered in the corner of the cave where she had her little prehistoric boudoir. To return to our hunter, however, who for aught we know to the contrary may be our old master himself in person, he is a rather crouching and semi-erect savage, with an arched back, recalling somewhat that of the gorilla, a round head, long neck, pointed beard, and weak, shambling, ill-developed legs. I fear we must admit that pre-glacial man cut, on the whole, a very sorry and awkward figure.

Was he black? That we don't certainly know; but all analogy would lead one to answer positively, Yes. White men seem, on the whole, to be a very recent and novel improvement on the original evolutionary pattern. At any rate he was distinctly hairy, like the Ainos, or aborigines of Japan, in our own day, of whom Miss Isabella Bird has drawn so startling and sensational a picture. Several of the pre-glacial sketches show us lank and gawky savages with the body covered with long scratches, answering exactly to the scratches which represent the hanging hair of the mammoth, and suggesting that man then still retained his old original hairy covering. The few skulls and other fragments of skeletons now preserved to us also indicate that our old master and his contemporaries much resembled in shape and build the Australian black fellows, though their foreheads were lower and more receding, while their front teeth still projected in huge fangs, faintly recalling the immense canines of the male gorilla. Quite apart from any theoretical considerations as to our probable descent (or ascent) from Mr. Darwin's hypothetical "hairy arboreal quadrumanous ancestor," whose existence may or may not be really true, there can be no doubt that the actual historical remains set before us pre-glacial man as evidently approaching in several important respects the higher monkeys.

It is interesting to note, too, that while the Men of the Time still

retained (to be frankly evolutionary) many traces of the old monkey-like progenitor, the horses which our old master has so cleverly delineated for us on his scrap of horn similarly retained many traces of the earlier united horse-and-donkey ancestor. Professor Huxley has admirably reconstructed for us the pedigree of the horse, beginning with a little creature from the Eocene beds of New Mexico, with five toes to each hind-foot, and ending with the modern horse, whose hoof is now practically reduced to a single and solid-nailed toe. Intermediate stages show us an Upper Eocene animal as big as a fox, with four toes on his front feet and three behind; a Miocene kind as big as a sheep, with only three toes on the front-foot, the two outer of which are smaller than the big middle one; and, finally, a Pliocene form, as big as a donkey, with one stout middle toe, the real hoof, flanked by two smaller ones, too short by far to reach the ground. In our own horse these lateral toes have become reduced to what are known by veterinaries as splint-bones, combined with the canon in a single solidly mortised piece. But in the pre-Glacial horses the splint-bones still generally remained quite distinct, thus pointing back to the still earlier period when they existed as two separate and independent side-toes in the ancestral quadruped. In a few cave specimens, however, the splints are found united with the canons in a single piece, while conversely horses are sometimes, though very rarely, born at the present day with three-toed feet exactly resembling those of their half-forgotten ancestor, the Pliocene hipparion.

The reason why we know so much about the horses of the cave period is, I am bound to admit, simply and solely because the man of the period ate them. Hippophagy has always been popular in France; it was practiced by pre-Glacial man in the caves of Périgord, and revived with immense enthusiasm by the gourmets of the Boulevards after the siege of Paris and the hunger of the Commune. The cave-men hunted and killed the wild horse of their own times, and one of the best of their remaining works of art represents a naked hunter attacking two horses, while a huge snake winds itself unperceived behind close to his heel. In this rough prehistoric sketch one seems to catch some faint antique foreshadowing of the rude humor of the "Petit Journal pour Rire." Some archæologists even believe that the horse was domesticated by the cave-men as a source of food, and argue that the familiarity with its form shown in the drawings could only have been acquired by people who knew the animal in its domesticated state; they declare that the cave-man was obviously horsey. But all the indications seem to me to show that tame animals were quite unknown in the age of the cave-men. The mammoth certainly was never domesticated; yet there is a famous sketch of the huge beast upon a piece of his own ivory, discovered in the cave of La Madelaine by Messrs. Lartet and Christy, and engraved a hundred times in works on archæology, which forms one of the finest existing relics of pre-

Glacial art. In another sketch, less well known, but not unworthy of admiration, the early artist has given us with a few rapid but admirable strokes his own reminiscence of the effect produced upon him by the sudden onslaught of the hairy brute, tusks erect and mouth wide open, a perfect glimpse of elephantine fury. It forms a capital example of early impressionism, respectfully recommended to the favorable attention of Mr. J. M. Whistler.

The reindeer, however, formed the favorite food and favorite model of the pre-Glacial artists. Perhaps it was a better sitter than the mammoth; certainly it is much more frequently represented on these early prehistoric bas-reliefs. The high-water mark of palæolithic art is undoubtedly to be found in the reindeer of the cave of Thayngen, in Switzerland, a capital and spirited representation of a buck grazing, in which the perspective of the two horns is better managed than a Chinese artist would manage it at the present day. Another drawing of two reindeer fighting, scratched on a fragment of schistose rock and unearthed in one of the caves of Périgord, though far inferior to the Swiss specimen in spirit and execution, is yet not without real merit. The perspective, however, displays one marked infantile trait, for the head and legs of one deer are seen distinctly through the body of another. Cave-bears, fish, musk-sheep, foxes, and many other extinct or existing animals, are also found among the archaic sculptures. Probably all these creatures were used as food; and it is even doubtful whether the artistic troglodytes were not also confirmed cannibals. To quote Mr. Andrew Lang once more on primitive man, "he lived in a cave by the seas; he lived upon oysters and foes." The oysters are quite undoubted, and the foes may be inferred with considerable certainty.

I have spoken of our old master more than once under this rather question-begging style and title of primitive man. In reality, however, the very facts which I have here been detailing serve themselves to show how extremely far our hero was from being truly primitive. You can't speak of a distinguished artist, who draws the portraits of extinct animals with grace and accuracy, as in any proper sense primordial. Grant that our good troglodytes were indeed light-hearted cannibals; nevertheless, they could design far better than the modern Esquimaux or Polynesians, and carve far better than the civilized being who is now calmly discoursing about their personal peculiarities in his own study. Between the cave-men of the pre-Glacial age and the hypothetical hairy quadrumanous ancestor aforesaid there must have intervened innumerable generations of gradually improving intermediate forms. The old master, when he first makes his bow to us, naked and not ashamed, in his Swiss or French grotto, flint scalpel in hand and necklet of bear's teeth dropping loosely on his hairy bosom, is nevertheless in all essentials a completely evolved human being, with a whole past of slowly acquired culture lying dimly and mysteriously

behind him. Already he has invented the bow with its flint-tipped arrow, the neatly chipped javelin-head, the bone harpoon, the barbed fish-hook, the axe, the lance, the dagger, and the needle. Already he had learned how to decorate his implements with artistic skill, and to carve the handles of his knives with the figures of animals. I have no doubt that he even knew how to brew and to distill; and he was probably acquainted with the noble art of cookery as applied to the persons of his human fellow-creatures. Such a personage can not reasonably be called primitive; cannibalism, as somebody has rightly remarked, is the first step on the road to civilization.

No, if we want to get at genuine, unadulterated primitive man, we must go much further back in time than the mere trifle of 250,000 years, with which Dr. Croll and the cosmic astronomers so generously provide us, for pre-Glacial humanity. We must turn away to the immeasurably earlier fire-split flints which the Abbé Bourgeois—undaunted mortal!—ventured to discover among the Miocene strata of the *calcaire de Beauce*. Those flints, if of human origin at all, were fashioned by some naked and still more hairy creature, who might fairly claim to be considered as genuinely primitive. So rude are they that, though evidently artificial, one distinguished archæologist will not admit they can be in any way human; he will have it that they were really the handiwork of the great European anthropoid ape of that early period. This, however, is nothing more than very delicate hair-splitting; for what does it matter whether you call the animal that fashioned these exceedingly rough and fire-marked implements a man-like ape or an ape-like human being? The fact remains quite unaltered, whichever name you choose to give to it. When you have got to a monkey who can light a fire and proceed to manufacture himself a convenient implement, you may be sure that man, noble man, with all his glorious and admirable faculties—cannibal or otherwise—is lurking somewhere very close, just round the corner. The more we examine the work of our old master, in fact, the more does the conviction force itself upon us, that he was very far indeed from being primitive—that we must push back the early history of our race not for 250,000 winters alone, but perhaps for two or three million years, into the dim past of Tertiary ages.

But if pre-Glacial man is thus separated from the origin of the race by a very long interval indeed, it is none the less true that he is separated from our own time by the intervention of a vast blank space, the space occupied by the coming on and passing away of the Glacial Epoch. A great gap cuts him off from what we may consider as the relatively modern age of the mound-builders, whose grassy barrows still cap the summits of our southern chalk-downs. When the great ice-sheet drove away palæolithic man—the man of the caves and the unwrought flint axes—from Northern Europe, he was still nothing more than a naked savage in the hunting stage, divinely gifted for art

indeed, but armed only with roughly-chipped stone implements, and wholly ignorant of taming animals, or of the very rudiments of agriculture. He knew nothing of the use of metals—*aurum irrepertum spernere fortior*—and he had not even learned how to grind and polish his rude stone tomahawks to a finished edge. He couldn't make himself a bowl of sun-baked pottery, and if he had discovered the almost universal art of manufacturing an intoxicating liquor from grain or berries (for, as Byron, with too great anthropological truth, justly remarks, "man, being reasonable, *must* get drunk") he at least drank his aboriginal beer or toddy from the capacious horn of a slaughtered aurochs. That was the kind of human being who alone inhabited France and England during the later pre-Glacial period.

A hundred and seventy thousand years elapse (as the play-bills put it), and then the curtain rises afresh upon neolithic Europe. Man meanwhile, loitering somewhere behind the scenes in Asia or Africa (as yet imperfectly explored from this point of view), had acquired the important arts of sharpening his tomahawks and producing hand-made pottery for his kitchen utensils. When the great ice-sheet cleared away he followed the returning summer into Northern Europe, another man, physically, intellectually, and morally, with all the slow accumulations of nearly two thousand centuries (how easily one writes the words! how hard to realize them!) upon his maturer shoulders. Then comes the age of what older antiquaries used to regard as primitive antiquity—the age of the English barrows, of the Danish kitchen-middens, of the Swiss lake-dwellings. The men who lived in it had domesticated the dog, the cow, the sheep, the goat, and the invaluable pig; they had begun to sow small ancestral wheat and undeveloped barley; they had learned to weave flax and wear decent clothing; in a word, they had passed from the savage hunting condition to the stage of barbaric herdsmen and agriculturists. That is a comparatively modern period, and yet I suppose we must conclude, with Dr. James Geikie, that it isn't to be measured by mere calculations of ten or twenty centuries, but ten or twenty thousand years. The perspective of the past is opening up rapidly before us; what looked quite close yesterday is shown to-day to lie away off somewhere in the dim distance. Like our palæolithic artists, we fail to get the reindeer fairly behind the ox in the foreground, as we ought to do if we saw the whole scene properly foreshortened.

On the table where I write there lie two paper-weights, preserving from the fate of the sibylline leaves the sheets of foolscap to which this article is now being committed. One of them is a very rude flint hatchet, produced by merely chipping off flakes from its side by dexterous blows, and utterly unpolished or unground in any way. It belongs to the age of the very old master (or possibly even to a slightly earlier epoch), and it was sent me from Ightham, in Kent, by that indefatigable unearther of prehistoric memorials, Mr. Benjamin Har-

rison. That flint, which now serves me in the office of a paper-weight, is far ruder, simpler, and more ineffective than any weapon or implement at present in use among the lowest savages. Yet with it, I doubt not, some naked black fellow, by the banks of the Thames, has hunted the mammoth among unbroken forests two hundred thousand years ago and more; with it he has faced the angry cave-bear, and the original and only genuine British lion (for everybody knows that the existing mongrel heraldic beast is nothing better than a bastard modification of the leopard of the Plantagenets). Nay, I have very little doubt in my own mind that with it some æsthetic ancestor has brained and cut up for use his next-door neighbor in the nearest cavern, and then carved upon his well-picked bones an interesting sketch of the entire performance. The Du Mauriers of that remote age, in fact, habitually drew their society pictures upon the personal remains of the mammoth or the man whom they wished to caricature in deathless bone-cuts. The other paper-weight is a polished neolithic tomahawk, belonging to the period of the mound-builders, who succeeded the Glacial epoch, and it measures the distance between the two levels of civilization with great accuracy. It is the military weapon of a trained barbaric warrior as opposed to the universal implement and utensil of a rude, solitary, savage hunter. Yet how curious it is that, even in the midst of this "so-called nineteenth century," which perpetually proclaims itself an age of progress, men should still prefer to believe themselves inferior to their original ancestors, instead of being superior to them! The idea that man has risen is considered base, degrading, and positively wicked; the idea that he has fallen is considered to be immensely inspiring, ennobling, and beautiful. For myself, I have somehow always preferred the boast of the Homeric Glaucus, that we, indeed, maintain ourselves to be much better men than ever were our fathers.—*Cornhill Magazine.*

SKETCH OF M. PIERRE E. BERTHELOT.

UNTIL a few years ago, investigation in organic chemistry was pursued almost wholly by the road of analysis. As Gerhardt wrote in his treatise: "The chemist did everything in opposition to living Nature. He burned, destroyed, and worked by taking apart, while the vital force operated by synthesis or putting together, to reconstruct the edifice which chemical forces would destroy." The chemist was, in fact, a great destroyer. He could isolate the essence from a flower, and could destroy that essence and determine its chemical composition, but he was powerless to reconstruct the destroyed perfume, and could not even conceive that such a thing was possible. It is the chief title to fame of M. Berthelot that he introduced the

synthetic method into organic chemistry, and devised a system of processes by means of which we are able to create organic compounds by the direct combination of their constituent radicals.

Pierre Eugène Marcellin Berthelot was born in Paris, October 25, 1827. He was the son of a physician of some distinction, and while a student in one of the lyceums of Paris showed marked tastes for philosophical studies and chemical research, so that, when the time for the contest came, he easily won the honors in philosophy. Then, following his favorite pursuits, he occupied himself especially with studies of the acids and fatty bodies, and of fermentations. In 1851 he became attached to the Collége de France as preparator in the course of chemistry, in which position he was assistant to Balard. In 1854 he propounded his theory of polyatomic alcohols, and was in the same year made a Doctor in Science. In 1859 he was appointed a Professor in the Superior School of Pharmacy. In 1861 he received the Joecker prize from the Academy of Sciences for his experiments in the artificial production of chemical substances by synthesis. In 1864 he was made a Professor of Organic Chemistry in the Collége de France in a chair which had been created especially for him, in which he was instructed to advance his own ideas, and to treat in his lectures especially of his own discoveries.

M. Berthelot entered upon the researches in synthesis, which give him his strongest title to fame, in 1854. Berzelius had said that, although we may produce with inorganic bodies a few substances having a composition analogous to that of some organic ones, the imitation is too restricted to justify us in hoping that we shall be able to produce organic bodies in the same sense that we have frequently succeeded in confirming the analysis of inorganic bodies by performing the synthesis of them. Yet, when this was said, Wöhler had already performed the synthesis of urea; and a few other syntheses had been made, but they were so isolated, so insignificant, and so barren of fruit, that all attempts to constitute organic bodies by bringing together the elements of which they are composed were, as a rule, regarded as chimerical. The law and the manner of the formation of the organic matters which enter into the composition of the living being were unknown; the question whether those substances were chemical in their character, or depended for their existence and maintenance upon a peculiar vital force, had been started, but the discussion of it had not been seriously entered upon. M. Berthelot began to give his attention to the solution of this problem very early in his scientific career.

One of the first syntheses he performed was that of formic acid, and this was used as the basis of his further researches. Regarding this substance as formed by the union of water and carbonic oxide, he brought about a compound of that character through the intervention of potash, and secured the result he sought. Other syntheses followed

this one, conducted, like it, with very simple compounds, till he was finally led to the artificial composition of the carburets of hydrogen. Among his most important experiments in this line was the artificial production of alcohol from olefiant gas. Alcohol once obtained synthetically, he had a station whence he could pursue his investigations in various directions. It was not a long step from this to the composition with the same elements (oxygen, hydrogen, and carbon) of a number of volatile organic substances—such as the oils of garlic, mustard, etc.—and then to the formation of glycerine. With these processes he had built up by synthesis what we might perhaps call the first story of organic chemistry. To complete his work it was necessary to produce the saccharine and albuminous substances which constitute what might be called, repeating our figure, the second story of the edifice—a problem of a more difficult character, because those substances are less stable in their nature, and are more completely decomposed under energetic chemical reactions. On this subject M. Berthelot said, several years ago: "The reconstitution of the saccharine and albuminoid principles is the final object of organic chemistry, the most remote one indeed, but also one of the most important, on account of the essential part which these principles play in our economy. When science attains it, it will be able to realize the synthetic problem in its whole extent—that is, to produce, with the elements and by the play of molecular forces alone, all the definite natural compounds and all the changes which matter undergoes in the bodies of living beings."

"The labors of M. Berthelot in this line," says an enthusiastic French biographer, "constitute one of those events which change the aspect of things, not only by the new processes which they have developed, or by the substances, more or less known, which they have given the means of reproducing, but because they have taken hold bodily of one of the strongest intrenched ideas of mankind and overthrown it. We had been taught that all the complex substances constituting plants and animals were produced wholly under the influence of a special vital force peculiar to organized beings. When it came to verifying the facts in the case, it was found that Nature acts in a more simple way than we had thought, and that she employs those chemical affinities that control the metamorphoses of matter equally in executing those immense earth-convulsions that stir the foundations of countries and overthrow cities, and in perfuming a flower by the distillation, molecule by molecule, of its essential oil."

The fruits of M. Berthelot's investigations in this department of research have been given in a number of publications, among which we may name the "Combinaisons de la glycérine avec les acides, et reproduction des corps gras neutres" ("Combinations of Glycerine with the Acids, and Reproduction of Neutral Fatty Bodies"), 1860; various memoirs in the "Annales de physique et de chimie"; "Chimie organique fondée sur la synthèse" ("Organic Chemistry founded on

Synthesis") 1860; and "Leçons sur les méthodes générales de synthèse en chimie organique" ("Lessons on the General Methods of Synthesis in Organic Chemistry"), a course of lectures in the Collége de France, 1864.

M. Berthelot has also pursued elaborate researches in specific heat, and in the relations between the heat developed in composition and decomposition, and the force of affinity. On the subject of the relations of specific heat with the composition of bodies he said, in 1873, in a discussion in the French Academy with M. Dumas: "The study of the specific heats established by the most recent researches tends to prove that there is a positive characteristic which, it seems to me, distinguishes the elements of modern chemistry from its compounds, and shows that no known compound body ought to be considered as of the same order as an actually simple one. The importance of such a characteristic can not be doubted, and it becomes greater on account of the mechanical meaning which modern theories attach to specific heat. . . . Nevertheless, exaggerated conclusions must not be drawn from such an opposition between the mechanical and physical characteristics of our simple and compound bodies. If our elements have not as yet been decomposed, and appear not to be decomposable by the forces which are at present at the command of the chemist, nothing compels us to assert that they are not decomposable in another way than our compounds are; as, for instance, as Mr. Lockyer asserts, by means of the forces acting in cosmical space. Nor does anything prevent that such a discovery as that of voltaic electricity would enable the chemists of the future to overpass the limits which are imposed upon us. The possible fundamental identity of the matter constituting our elements, and the possibility of transmuting into one another the so-called elements, can, moreover, be admitted into the category of more or less plausible hypotheses without it necessarily resulting that there is a single really existing matter of which our actual elements represent unequal states of condensation. In fact, nothing compels us to conceive the existence of a final decomposition which shall tend necessarily to reduce our elements either to more simple bodies, from the addition of which they arise, or to multiples of a single elementary ponderable unit."

M. Berthelot's views of the relations between chemical affinity and the intensity of chemical action were presented in his "Essai de mécanique chimique fondée sur la thermo-chimie" ("Essay on Chemical Dynamics based on Thermo-Chemistry"), 1880, of which Mr. M. M. Pattison Muir said, in "Nature," that its publication "marks an important point in the advance of modern chemistry." Among the more recent investigations which M. Berthelot has pursued in the light of his thermo-chemical theories are those into the properties of explosives and the laws of the propagation of explosions.

CORRESPONDENCE.

FRUCTIFICATION OF THE FIG.

Messrs. Editors:

DEAR SIRS: Some time ago I wrote to my son, Grant Allen, to say that, in that special portion of his article ("Queer Flowers") which referred to the fructification of the fig, there must, I thought, be some mistake, for I had seen a fig-tree bear a large crop of fruit, and was sure that no such pains had been taken with it as that referred to in the article in question. To this I received yesterday (March 11th) the following reply, which, though intended only for myself, I think I break no confidence in publishing: "The fig-tree question," says he, "puzzled me myself much, long ago, for the *caprifico* doesn't grow in England, and fig-trees bear abundantly. But all the authorities are unanimous, and I can't go against them. There is a vast literature on the subject, caprification as they call it, and Müller in his 'Fertilization of Flowers' gives a list of *ten separate works* dealing with it." So that, if he has erred, he has erred *cum patribus*. So far for my son. Now Müller, who is a specialist on this subject, and the latest and very highest authority, tells us (see "The Mechanisms of Flowers," part iii, page 521) that "*the latest researches* (377, *Ficus carica*, L.) *confirm* the fact, which Linnæus (416 A.) was aware of, that the so-called *caprificus* which bears inedible fruit, and the fig-tree, cultivated for the sake of its fruit from time immemorial, stand in the relation of male and female to one another. Fertilization is effected by a wasp. . . . In most cases, each crop of figs, whether of the fig-tree or the caprificus, brings only flowers of one sex to maturity." Again (p. 522): "While the fruit of the caprificus, whose only use is to supply pollen, remains hard and withers on the tree, or falls off without becoming sweet, the fruit of the fig-tree, when the seeds ripen, becomes sweet and juicy, and so attracts birds which disseminate the seeds. From the most ancient times, as long as the fig-tree has been cultivated, its artificial fertilization by means of the caprificus, or so-called caprification, has been practiced," and so on.

How are we to reconcile all this with the very lucid exposition and array of facts of your able correspondent in the February number of "The Popular Science Monthly." I confess I think your correspondent is in this particular right. Only that I do not wish to venture a guess—never permissible on a question of science, save tentatively—I might make one here as to how these differences might be reconciled, but I forbear.

Though my son is a keen and close observer of Nature, and a good judge of the men to be relied on for such facts as, in his yet short life, he could not have scrutinized himself personally, yet as *his* more especial object is to get at the heart of his facts, to read their hidden meaning, and to show how whole continents of facts, apparently disconnected and unrelated, are yet bound together by the strongest ties of consanguinity or more close or distant relationship, he has very frequently to go to the works of able specialists of repute in order to learn from them what they have observed.

Thus, for example's sake, in a late article of his in the "Cornhill Magazine" ("Go to the Ant") he had, as is obvious, to have recourse to the vast stores of observations accumulated by many able specialists in many parts of the world. Now, it is quite possible that some of these observations may in time come to be questioned by more exact observers; still, in a case like this of the fig-tree, when all practical men and scientific observers have coincided in opinion, and where "all authorities" have for over a century been "*unanimous*," a writer is to be pardoned for thrusting aside a difficulty in his own mind, in deference to the practical judgment of the ages and the decision of all experts in the case.

I sent my son by to-day's post the number of "The Popular Science Monthly" which contained the letter of your correspondent; but I wish it to be borne in mind that the reply here given is mine, not his, save in the few words quoted from a *private* letter and dashed off by him in great haste. His reply, on seeing your correspondent's letter, might be very different.

Yours very truly, J. ANTISELL ALLEN.

March 12, 1885.

Messrs. Editors:

IN the February number of "The Popular Science Monthly," Mr. George Pyburn, of Sacramento, says, "I have yet to see the first seedling fig," and suspects, therefore, that the seeds are generally infertile.

In 1878 I planted the seeds of an imported white Smyrna fig. They germinated abundantly, and, in the fourth year from planting, my seedling fig-tree bore fruit. I shall try this year a similar experiment with a California fig. I anticipate a similar result. The seeds are so small that they require care. They should be planted

in a box, covered shallow with fine sand, and regularly watered with a sprinkler.

I think figs generally are self-fertilizing. I had one tree, however, whose fruit uniformly fell when about two thirds grown. I ascribed this to want of fertilization. Possibly the presence of the *caprifico* might have changed results. If so, it would follow that some varieties are self-fertilizing and others not. The "fig-wasp" is unknown here.

The "novel phenomenon" related by Mr. C. G. McMillan may be found duplicated, though not in precisely the same way, in Northern Mississippi. His fossil leaves had retained their color during untold ages. In the other case it was the resin of the pine-tree. Near the village of Iuka was lying, some twenty years ago, and perhaps is still, a petrified pine-log about two feet in diameter, a ten-pound fragment of which lies here in my study. Not only does the stone retain the color and appearance of pine-wood, but the petrified resin has the color, semi-transparency, and general appearance of real resin. The surface-land is eocene.

ISAAC KINLEY.

LOS ANGELES, CAL., *March* 11, 1885.

SAMP AND HULLED CORN.

Messrs. Editors:

MATTIEU WILLIAMS, in article 42 of his "Chemistry of Cookery" ("Popular Science Monthly" for January), says: "Before proceeding further I must fulfill the promise made in No. 39, to report the result of my repetition of the Indian process of preparing *samp*. I soaked some ordinary Indian corn in a solution of carbonate of potash, exceeding the ten or twelve hours specified by Count Rumford. The external coat was not removed even after two days' soaking." He suspects the corn was too old and dry, and that the Indians used new or freshly gathered grain.

In the first place, this is not the way to prepare *samp*. Samp is the Anglicized Indian name for maize parched and pounded. It came afterward to be the name for the new corn, pounded or coarsely ground. This being done before the kernels were fairly dry, it was much prized for mush or hasty-pudding.

The prepared Indian corn he refers to is called in New England *hulled corn*. My grandmother, whose parents were contemporary with and from the same part of the country as Count Rumford, was famous for her hulled corn.

That this method of preparing corn for food was learned from the Indians is uncertain. It was probably a Yankee invention of early date.

Grandmother's way was to put a peck of old, dry maize into a pot filled with water, and with it a bag of hard-wood ashes, say a quart. After soaking a while it was boiled until the skins or hulls came off easily. The corn was then washed in cold water to get rid of the taste of potash, and then boiled until the kernels were soft. Another way was to take the lye from the leaches where potash was made, dilute it, and boil the corn in this until the skin or hull came off. In the experiment tried by Mr. Williams, his solution of carbonate of potash was not of sufficient strength, or, if it was, the maize or corn should have been boiled. It makes a delicious dish, eaten with milk or cream.

In the early days of New England, maize was the principal grain, and was designated *corn*, which is the significance of the name now in all parts of the Union. Ground maize is called in New England "Indian-meal," and mixed with one third of rye-meal, fermented and baked, once constituted the principal bread of the whole country. It was called "rye-and-indian," pronounced *ryningen*. Boston brown bread is an imitation of it. Baked Indian is still a common appellation for a corn-meal pudding that strikes a stranger as a reminiscence of cannibalism.

P. J. F.

CLINTON, IOWA, *March* 20, 1885.

EDITOR'S TABLE.

ILLITERACY AS A SOURCE OF NATIONAL DANGER.

A GREAT deal of attention has lately been drawn to this subject, and in certain quarters an attempt has been made to "boom" it in a manner that can hardly be pronounced entirely disinterested. In certain educational journals, for example, teachers are urged to petition the national Legislature for the passing of the "Blair Bill," on the ground that it will improve their own remuneration. One form of petition, which we find printed for the convenience of teachers, states that "ignorance among the masses of the people now exists to such a degree as to threaten the early destruction of the free institutions of the republic," and that therefore a system of free schools

"should be in part established and, temporarily at least, supported by contributions from the overflowing Treasury of the United States." The word "temporarily" here will raise a smile on the lips of those who remember how often temporary protection for "our infant industries" has been applied for, and how invariably the protection so accorded has become a permanent thing. Infant industries that are nourished on "protection" never emerge from the infant condition. However they may extend and expand, they never voluntarily forego the leading-strings or the pap-bottle; and so we shrewdly suspect it would be with the schools "temporarily" assisted by the Federal Government. If, in the course of a few years, they demonstrated their ability to dispense with such assistance, they would do what has seldom been done in this world. It is a most unusual thing for any organism to close an easy channel of alimentation, in order to depend exclusively upon one more difficult. Let the Treasury of the United States once begin to overflow in the way of aid to education "on the basis of illiteracy," it may go on overflowing. The "basis" is not likely to contract, but rather to widen out from year to year.

The question, however, deserves careful consideration. Is the stability of our institutions threatened by the ignorance of the electorate? By "illiteracy" is understood the condition of being unable to read or write; and we are asked to believe that our system of government stands in peril on account of the extent to which illiteracy as thus defined prevails. The language used would point to the conclusion that illiteracy is now a more serious evil than at any previous period of our history. The facts, however, do not support any such conclusion. The census of 1870 gave the total number of white males of voting age unable to write as 748,970. From 1870 to 1880 our population increased thirty per cent. Had the number of illiterates remained, therefore, relatively stationary, we should have had in 1880 not less than 973,661 white voters unable to write; instead of that, the census for that year shows the number to be 886,659 only, a decidedly reduced proportion. It is true, on the other hand, that, among the colored population, education is not keeping pace with the natural increase of numbers, but this fact alone does not justify the interference of the Federal Government to supplement the educational work that is now going on.

What has not been shown as yet, so far as we are aware, is that the so-called illiterate classes are a specific source of danger to our institutions. If we review the several crises of our history, we shall probably find that those who have done most to bring on these crises have been, for the most part, men quite able to read and write. The Tilden-Hayes imbroglio could not certainly be traced to the ignorance of the electorate. Maine is a highly educated State, and yet it was precisely there that a few years ago a condition of war almost supervened in connection with the State elections. The false returns which kept this city, and in a less degree the whole Union, in a condition of fever-heat for days together last fall, had nothing to do with illiteracy, quite the contrary. Even the Cincinnati riot was not the work of men who could not read or write, but rather of citizens quite competent in these respects, but who had momentarily lost their heads. The fact is, the citizens who can read and write have everywhere the power in their own hands, and if they are only willing to discharge their duties, private and public, in a proper manner, the non-reading and non-writing element in the population will give them comparatively little trouble.

There is, however, another view to be taken of the matter. If our schools are not as efficient as they should be, and if an undue proportion of the whole population escapes the civilizing influence of education, what is the

cause? We do not hesitate to say that the chief cause is one which no Government action, State or Federal, can ever reach—viz., defect of home discipline. The boy who will not attend school, or who, attending school, learns nothing, is the boy accustomed to rebellion at home, or the boy whose parents are themselves too negligent and vicious to care whether he learns anything or not. It is no doubt the case that a certain portion of the population of these States is being brought up in partial or total savagery. Not for want of schools, however, for schools abound. The evil is deep-seated, and can only be reached by the vigorous action of public opinion, and by wise measures of reform in connection with the administration of justice. When we explain why it is that our educational systems fail altogether to reach a certain element in the population, we explain, also, why the work of education is in many cases so shallow, and why it even seems at times to do more harm than good. Everything depends on the spirit with which it is approached. A well-known figure in contemporary fiction—Maud Matchin—well illustrates the work of the high-school or academy on the mind of a vain and vulgar girl, who sets no value upon education, save as it may help her to a position in the world, and the vices of whose character are therefore brought only into stronger relief by her wretched varnish of accomplishments. And here we see the folly of all schemes that would set the Federal Government at work to repair the weak places of education throughout the States and Territories. All that is proposed is that reading and writing should be made universal accomplishments, so as to remove the reproach and danger of technical "illiteracy." But there is absolutely no guarantee that the voter newly instructed to read and write would be any better *man* than he was before. If our high-schools are turning out Maud Matchins by the score and hundred, and if youths by the thousand leave school to pursue a career of "smartness," without one thought of social responsibility, it is evident that the mere extension of educational facilities is a much less pressing need than the moralizing of the whole business of education. Philosophers have told us that it is perfectly possible to educate in an intellectual sense without touching one single moral chord; and daily experience confirms the truth of the statement. Instead, therefore, of engaging the Federal Government to establish more schools, we would engage the whole community to place the schools that now exist upon a higher moral plane, and to render them more effectual in their working by a higher quality of home influence. It is in the home above all that reform is needed; but, unhappily, the school has of late years so dwarfed the home, so interposed between the parent and his natural and proper responsibility toward his child, that to preach "home influence" to-day is almost like raising one's voice in the wilderness. Things are badly complicated; one thing only is certain, and that is, that more State interference will not help to clear up the complications, or to put things on a sound basis.

It is needless, we trust, in concluding these remarks, to say that we yield to none in the importance we attach to education rightly understood. By education, however, we do not understand merely the ability to read and write, and we are not fully persuaded that our institutions would be any safer than they are to-day if every child in the country over twelve years old could both read and write. What we know for certain is, that an individual able to do both may be in a condition of very unstable intellectual equilibrium, and so, we believe, might a whole community of such individuals. What we need to improve our intellectual state is not an increase of activity on the part of the Government, but deeper convictions

of social duty throughout the community, and, above all, a livelier sense of parental responsibility. Let us have these things, and the republic will be safe, and education will begin to be truly humanizing and truly progressive.

A TEST OF PHILOSOPHY.

THERE is now a pretty decided agreement among the intelligent and unprejudiced that Herbert Spencer takes rank as the first philosopher of England, and G. H. Lewes many years ago declared him to be the *only* English thinker who has originated a philosophy. How much this may mean is well intimated by the remark of Mr. Lester F. Ward, that, "when we have reached England's greatest in any achievement of mind, we have usually also reached the world's greatest."

But there is still room to regard the compliment as equivocal, for the question remains, What is it to be "the first philosopher"? To be first and alone in a department of thought obviously means little or much, according to the grade of intellectual work involved. Philosophy is a vague term, and, as experience shows, may imply the lowest as well as the highest exercise of the mind. As applied to systems of speculation in pre-scientific ages, it no doubt represented the best mental effort then possible. But as applied in these times to similar speculations, with little reference to the rise of modern knowledge, it is not the highest kind of intellectual performance. True philosophy — the deepest and largest understanding of things — must be so far scientific in spirit and method as to place facts first, and work in subordination to them. The philosophy that is typified by the Concord school, which is most interested in the transcendental, which gives imagination the lead, leaves vulgar facts to the Gradgrinds, and is as jealous of science as theology, is not a very exalted form of mental exertion, and to be first in it is no great compliment. Philosophy, to achieve its highest objects, must now begin with the patient study of long-contemned realities; must discipline the imagination, must work in subordination to established knowledge, and aim to bring out profounder truth for the practical guidance of man in ordering the course of his life.

To be the first philosopher of the foremost nation of the world from this point of view is exalted praise, and this is the position that Mr. Spencer has undoubtedly won. His philosophy is based upon Nature, is limited to Nature, is subordinated to science, and is such a presentation of the laws and order of the world as bears immediately upon questions of human conduct. It is synthesis of the principles which become all-determining rules in the practical sphere of human action. It bears upon religion, upon politics, upon education, and upon social and domestic experience, with the authority of science and the full power of a verified system of natural laws. It was long a reproach to Spencer that he undertook to deal with so many subjects, but it is now perceived that this was but the inevitable consequence of that comprehensive method which the advance of modern knowledge had made possible and imperative.

We have been led to these remarks by a circumstance, not in itself of much importance, but which is yet significant as giving a new attestation of the worth of Spencer's philosophy in its practical bearings. Mr. Spencer has applied his philosophical views to the subject of education, and his little treatise upon the subject has been rendered into all the languages of the civilized world. And now, by an appeal made to the judgment of English teachers, the verdict has been rendered that the first of English philosophers is also the first of English educators. We see, by the London "Journal of Education," that an extra prize was offered for the best list

of the seven greatest living educationists classed in the order of importance. A great number of lists were sent in, and the prize was awarded to "X. Y. Z." for the following list: 1, Spencer; 2, Huxley; 3, Wilson; 4, Thring; 5, Miss Buss; 6, Laurie; 7, Quick. Besides this premium list, in which the name of Spencer was first in importance, his name also appeared in seventy-two other lists, while Bain appeared in fifty; Huxley, thirty-eight; Thring, thirty-six; Miss Beale, thirty-four; Miss Buss, thirty-three; R. H. Quick, thirty-two; E. A. Abbott, thirty-one; A. J. Mundella and J. G. Fitch, twenty-nine; J. Ruskin and M. Arnold, twenty-eight.

It has been said in deprecation of Spencer that "only the Seven Sages can understand him"; but it seems that practical teachers can sufficiently understand him to be able to form a very appreciative estimate of his position in the field where they are the most competent judges.

LITERARY NOTICES.

AMERICAN POLITICAL IDEAS: Viewed from the Stand-point of Universal History. Three Lectures delivered at the Royal Institution of Great Britain, in May, 1880. By JOHN FISKE. New York: Harper & Brothers. Pp. 158. Price, $1.00.

As many will be gratified to learn, Mr. Fiske has at length published the brief course of lectures upon "American Political Ideas" which attracted so much attention at the time of their delivery in England, and subsequently in this country. They afford an excellent popular illustration of the scientific method in politics, and as an original statement of the place of American political institutions in the progress of civilization they will be read with deep interest and patriotic pride by multitudes of our thoughtful citizens. Under the three titles of "The Town-Meeting," "The Federal Union," and "Manifest Destiny," the author gives us a pregnant discussion of the ideas that are at the foundation of true political development, of their historic growth, and the vast consequences to the world of their present success and their future ascendency.

Mr. Fiske takes the "town-meeting," the idea of which is so thoroughly familiar in this country, as the elemental basis of our political system. He devotes his first lecture to the consideration of it as involving the principle of local self-government. The present or absence, in various degrees, of institutions corresponding to this, in different countries, is shown to be intimately connected with the progress of free government, and to have exerted a powerful control over the character and destiny of nations.

Having treated of the corporate units of society, the township, the village, the parish, or whatever grouping becomes the seat and center of local self-control, Mr. Fiske passes in his second lecture to the important problem of their combination or aggregation into coherent extended political organizations. In communities of despotic type this is done by conquest and centralized military power. But wherever and to the degree in which civilization or civil agencies have replaced militancy, the principle of representation arises, and the freer mode of government takes the form of federal union. Mr. Fiske illustrates the progress and vicissitudes of the federal principle very impressively from Greek, Roman, and modern history, and in the United States, where representation and federal unity have received their largest application.

The third lecture, on "Manifest Destiny," is a brilliant and powerful exposition of the vast scale and comprehensive interaction of the political forces that are now so potent in civilization, and that are destined to work out grand results in the future. He shows that civilization is to conquer through peace; that the militant countries will have to disband their armies under the irresistible influence of the industrial competition of nations; and that the pacific federation of great communities is as certain to replace brute force in the politics of the civilized world as civil processes have replaced arbitrary violence in the private relations of men. The real significance of the American civil war is shown to consist in the vindicated strength and supremacy of the great pacific and constructive federative principle which is to dominate in the political future

of civilization; and the data are given by which to forecast the stupendous future of the English race, not only on this continent, but throughout the world.

Although written with sobriety, to be submitted to the critical judgment of a cultivated audience, yet these lectures are a good deal stirring and stimulating in their effect upon the reader's mind. This is due both to the charm of the presentation and to the magnitude of the elements of the author's imposing theme. "The stand-point of universal history" affords an exciting outlook, and Mr. Fiske gives his readers a clear command of the position. The author of "Cosmic Philosophy," with whom the conception of universal evolution has become part of his mental constitution, is well prepared to handle historical questions in the fullest breadth of their bearings, and the interest of the present book is chiefly derived from this preparation of its author. It may, in fact, be commended as a specially instructive study in political evolution. This is well explained by Mr. Fiske in the following prefatory passage:

> In the three lectures now published I have endeavored to illustrate some of the fundamental ideas of American politics, by setting forth their relations to the general history of mankind. It is impossible thoroughly to grasp the meaning of any group of facts in any department of study until we have duly compared them with allied groups of facts; and the political history of the American people can be rightly understood only when it is studied in connection with that general process of political evolution which has been going on from the earliest times, and of which it is itself one of the most important and remarkable phases. The government of the United States is not the result of special creation, but of evolution. As the town-meetings of New England are lineally descended from the village assemblies of the early Aryans; as our huge Federal Union was long ago foreshadowed in the little leagues of Greek cities and Swiss cantons—so the great political problem which we are (thus far successfully) solving is the very same problem upon which all civilized peoples have been working ever since civilization began. How to insure peaceful concerted action throughout the whole, without infringing upon local and individual freedom in the parts, this has ever been the chief aim of civilization viewed on its political side; and we rate the failure or success of nations politically according to their failure or success in attaining this supreme end. When thus considered in the light of the comparative method, our American history acquires added dignity and interest, and a broad and rational basis is secured for the detailed treatment of political questions.

THE NATURE AND REALITY OF RELIGION. A Controversy between FREDERIC HARRISON and HERBERT SPENCER. With an Introduction, Notes, and an Appendix on the Religious Value of the Unknowable, by Count D'ALVIELLA. New York: D. Appleton & Co. 1885. Pp. 218. Price, cloth, $1; paper, 50 cents.

THAT there is a "chaos of discordant opinion" in the religious world is a common remark, and, superficially regarded, the remark is true enough. There are divers great religious systems accepted by vast multitudes which exemplify profound diversities of belief; and these systems are broken up into sects innumerable, all marked by divergences of religious opinion. Yet this state of thought is by no means a "chaos"; there are order and law in it. Religious phenomena exhibit their predictable sequences of cause and effect. It may be counted on that people generally will stick to the faith into which they were born, and to the sect in which they were brought up, regardless of any question of the rationality of the creed they hold. Indeed, the tenacity with which, generation after generation, they cling to the accidental tenets they inherit, is an element of order which gives to religious organizations their stability and permanence.

Yet the condition of the religious world is by no means one of absolute immobility and stagnation. To the degree in which the human mind is active, religion shares the result. While many are quiescent, a few are ever inquiring, and, with increasing enlightenment and growing knowledge, the superstitious element in religion gradually diminishes and disappears. This, too, is an orderly change, and goes on in the religious world by the established laws of progress.

Such controversies as those of Spencer and Harrison are, hence, quite in the course of things. With whatever considerations of personality they may be mixed up, they are products of religious advancement, and still further contributions to it. The present discussion, however, is of more than usual significance, as it is not occupied with incidental but with fundamental religious questions. The conception of progress in religion is unquestionably revolutionizing and destructive, and no problem is more profound or momentous than that which

seeks to determine the final result of religious evolution. However it is to be commended, or however deplored, the advanced mind of this generation is deeply engaged with the most radical religious questions; and it is fortunate, when, as in the present case, the contestants are men of earnestness, sincerity, and reverence, as well as of fearlessness, brilliancy, and power. To the readers of the "Monthly" nothing need be said in regard to the special merits of this controversy, except that they will find the volume convenient from the completeness of the views it presents.

LAND-LAWS OF MINING DISTRICTS. By CHARLES HOWARD SHINN. Baltimore: N. Murray. Pp. 83. Price, 50 cents.

MINING-CAMPS. By CHARLES HOWARD SHINN. New York: Charles Scribner's Sons. Pp. 316. Price, $2.

THESE two works present the results of an investigation into the history of mining-camps, undertaken with a hope of giving the forms of social organization manifest in the early "districts" of the Sierras, Coast Range, and Rocky Mountains, their proper place in the story of institutional development on American soil. The work first named is one of the "Johns Hopkins University Series of Studies in Historical and Political Science"; and the editor of the series introduces it with the intimation that it is a "natural, though unconscious, continuation of Mr. Johnson's study of 'Rudimentary Society among Boys,'" which we have already noticed, "and that it might be called 'Rudimentary Society among Men.'" The second work is of larger scope and more fully wrought out. Mr. Shinn has done a good work in elucidating some peculiar phenomena of social and political development. What his essays teach may be illustrated by quoting one of the passages in "Mining-Camps": "In every important particular the organizations of the typical mining-camps, which we have been considering, offer sharply-outlined contrasts. Camp-law has never been the enemy of time-tried and age-honored judicial system, but its friend and forerunner. Axe of pioneer and pick of miner have leveled the forests, and broken down the ledges of rock, to clear a place for the stately structures of a later civilization. Rude mountain courts, rude justice of miner-camps, truth reached by short cuts, decisions unclouded by the verbiage of legal lexicons, a rough-hewed, sturdy system that protected property, suppressed crime, prevented anarchy—such were the facts; and on these frontier government rests its claims to recognition as other than mob-law, and better than passionate accident."

"THE JUKES": A Study in Crime, Pauperism, Disease, and Heredity. By R. L. DUGDALE. Fourth edition. New York: G. P. Putnam's Sons. Pp. 121. Price, $1.25.

THIS book embodies the substance of a famous paper, which, first published in the report of the Prison Association for 1877, has probably done more to promote the investigation of methods for the reform of criminals and the prevention of crime than any other single document of the time. It is, as the editor, Mr. Round, says in the introduction, "known, read, and valued wherever the civilization of the world has advanced far enough to be alarmed at the increase of crime, and to be concerned in reducing the criminal classes." It relates the story of a large family of criminals, prostitutes, and vagrants, which infested a group of counties in New York for two or three generations, all the descendants of a prostitute who was left to go her ways for evil unrestrained by any efforts to reclaim her. A new edition has been demanded in the interest of penal science. The original paper is supplemented with further studies of criminals, and an introduction insisting on the importance of the investigations by Mr. William M. F. Round, Secretary of the National Prison Association.

A POPULAR EXPOSITION OF ELECTRICITY. With Sketches of some of its Discoverers. By the Rev. MARTIN S. BRENNAN. New York: D. Appleton & Co. Pp. 191. Price, 75 cents.

THE object of this book is to make all familiar with the essential principles, at least, of the science of electricity; a purpose which none of the learned and excellent treatises devoted to the subject, "but so illustrated with complex and intricate mechanical diagrams as to frighten away the timid and uninitiated," seem adapted to

effect. The author has, therefore, devoted his attention almost entirely to the explanation of principles, to the exclusion of mechanics. He has aimed to exhibit the identity of all the forms of electricity, and has accordingly so arranged the matter of his treatise that each succeeding form shall appear to flow naturally from its predecessor. For the biographical sketches, those men have been selected whose discoveries have added most to the science; and the sketches are so distributed that each one shall be in logical juxtaposition with those branches of the science that have been most conspicuously illustrated by its subject. In the several chapters are given explanations of magnetism; the "Mariner's Compass," statical and atmospheric electricity, galvanism and galvanic batteries, electro-chemical decomposition, electrotyping and gilding, electro-magnetism, the electric telegraph, magneto-electricity and dynamos, the storage of electricity, the telephone, the aurora borealis, and Faraday's observations on table-moving. The subjects of the sketches are Faraday, Franklin, Galvani, Volta, Oersted, Ampère, and Professor Morse.

THE CARE OF INFANTS: A Manual for Mothers and Nurses. By SOPHIA JEX-BLAKE, M. D. London and New York: Macmillan & Co. Pp. 109. Price, 40 cents.

THE subject of this primer is a most important one, especially in view of the frightful rate of infant mortality that prevails, largely the result of ignorance and carelessness. The author is a most competent person to discuss it. Her purpose, she says, is "to supply, in the simplest and easiest possible way, the few leading facts respecting infant existence, and to specify, as briefly and clearly as may be, the treatment demanded by Nature and common sense for the preservation of the frail little lives that are perishing by millions for want of it."

ANNUAL AND SEASONAL CLIMATIC MAPS OF THE UNITED STATES. By CHARLES DENISON, Denver, Colorado. Chicago: Rand, McNally & Co. Five Maps, in Colors, variously mounted.

THESE maps are compiled from the returns of the Signal-Service Office, and are designed to show, graphically, by an equable standard and on impartial authority, chiefly, the average amount of cloudiness and precipitation at every place in the United States, for the year and for each season. In addition to this, they give the isothermal lines, the directions of prevailing winds, and of winds that usually and those that do not usually bring rain or snow, elevation above the sea, location of mineral springs, annual, monthly, and daily ranges of temperature, and other information that can be given graphically, or in a table, relating to the climatology of our country. The maps can be had separately, or, as in the case of the set submitted to us for examination, mounted on opposite sides of the same sheet.

CONTROLLING SEX IN GENERATION. By SAMUEL HOUGH TERRY. New York: Fowler & Wells Company. Pp. 147. Price, $1.

THIS is an attempt to discover the physical law influencing sex in the embryo of man and brute, and its direction to produce male and female offspring at will. The subject is an important one to breeders, and the author thinks he has discovered its law, claiming that the determination of the sex of offspring in all life lies in the separate physical conditions of the two parents. In his book he shows how he has reached his conclusion, brings forward the evidence by which he believes it is sustained, and makes suggestions respecting its practical bearing.

THE NATIONAL DISPENSATORY. Containing the Natural History, Chemistry, Pharmacy, Actions, and Uses of Medicines. By ALFRED STILLÉ, M. D., and JOHN M. MAISCH, Ph. D. Third edition. Philadelphia: Henry C. Lea's Son & Co. Pp. 1,755, with 311 Illustrations.

THE first edition of the "National Dispensatory" was published in 1879. It included descriptions of all crude drugs and chemical and pharmaceutical preparations, officinal in the Pharmacopœias of the United States and Great Britain, together with the more important medicines of the French Codex and German Pharmacopœia which were, to some extent, prescribed here, or which might serve for comparison with similar articles in the English and American standards; also, of drugs not recognized by any pharmacopœia, but often kept in the shops

because they were prescribed by physicians, or used in domestic practice, either entered under their own headings, or as "allied drugs" under those of more important substances. With these descriptions was given such information about the botanical character of plants yielding drugs, the external and structural characteristics, and the modes of preparation of drugs, their chemical properties, and their physiological action as determined by experiment, as seemed appropriate to the purposes of the work. The present edition may be regarded as embodying the pharmacopœias of the four chief civilized nations. Those of the United States and Germany appeared at the close of 1882, and formed the basis of the revision. The French Codex was published after the work was prepared for the press, but in time to admit of its incorporation. The British Pharmacopœia has not been revised since 1867. Many of the newer statements have been tested and corrected by special experiments. A large number of extra-pharmacopœial medicines have been added to those in previous editions. Numerous historical notes have been added. The descriptions have been condensed or extended as occasion seemed to require, and microscopical structure has been more fully described and illustrated. While the most recent views of the physiological action, so far as it explains the curative effects of medicines, have been given, all generalizations have been kept subordinate to the practical character of the work. The General Index contains more than 3,700 more references than that of the second edition, and the Index of Therapeutics nearly 1,600 new references. The references to authorities in the therapeutical portion of the work have been extended.

OCCULT SCIENCE IN INDIA AND AMONG THE ANCIENTS, with an Account of their Mystic Initiations, and the History of Spiritism. By LOUIS JACOLLIOT. Translated by Willard L. Felt. New York: John W. Lovell Company. Pp. 275.

IT may be well to say, in view of the manner in which the title has been used by a certain sect, that this is apparently a real historical study and an account of phenomena which, whatever may be their character, exist and have not been explained. The author is Chief-Justice of Chandernagore, in the French East Indies, and of Tahiti, who has, during long residence in India, given considerable attention to investigations of the subject, and to observations of the practices of those who have been initiated into the sect of the Pitris, or ancestral shades. The book, he declares, is neither a doctrinal one nor a work of criticism. He does not feel himself called upon to decide either for or against the belief in spirits, either meditating or inspiring, which was held by those who had been initiated in the temples of antiquity, and which is the keystone of the philosophical and religious instruction of the Brahmans; therefore he regards himself as the better able to write its history. He assumes to give "the words themselves," and set forth things as they actually were; to interpret and explain the philosophical compendium of the Hindoo spiritists; to tell what he saw with his own eyes, and faithfully record such explanations as he received from the Brahmans. He pays attention to the phenomena which the fakirs produce at will, which are variously regarded, but concerning which he remarks that "the facts which are simply magnetic are indisputable, extraordinary as they may seem. As to the facts which are purely spiritual, we were only able to explain those in which we participated, either as actor or spectator, upon the hypothesis that we were the victims of hallucination, unless we are willing to admit that there was an occult intervention."

THE SANITARY ENGINEER. Conducted by HENRY C. MEYER. Volume X. June to November, 1884. 140 William Street, New York. Pp. 612. Price, $4 a year.

THE "Sanitary Engineer" is a journal of civil and sanitary engineering and public and private hygiene, and gives particular attention to plumbing and the construction and arrangement of houses, with reference to sanitary conditions. The present volume contains many valuable papers; among them those relating to the International Health Exhibition, to describing and illustrating the plumbing, heating, ventilating and lighting of notable buildings, to steam-fitting and steam-heating, and the reports of various hygienic conventions.

JOHNS HOPKINS UNIVERSITY STUDIES IN HISTORICAL AND POLITICAL SCIENCE.

THE projectors of the "Johns Hopkins University Studies in Historical and Political Science" offer a third series of their monthly monographs, which have proved so valuable and instructive, to be devoted to American institutions and economies. The series will include papers on "Local and Municipal Government," "State and National Institutions," and "American Socialism" and "Economies." The numbers may be obtained separately, or the series as a whole after it is completed, from N. Murray, publication agent, Baltimore.

ONE HUNDRED YEARS OF PUBLISHING, 1785–1885. Philadelphia: Lea Brothers & Co. Pp. 20.

THIS is a memorial volume commemorative of the hundredth year of the publishing house whose imprint it bears. The business of the house was founded by Matthew Carey, an Irish exile, who began a daily paper in 1785, to which he soon added a monthly magazine. He and his successors then published quarto Bibles—the Douay and authorized versions—the Waverley Novels, the works of Fenimore Cooper, Washington Irving, and other early American authors, with some encyclopedic books which evinced considerable boldness of enterprise for their day, and introduced the American public to the genius of Charles Dickens. Gradually the business of the house tended to medical and scientific publications, to which, giving up literary and miscellaneous works, it has of late years been exclusively devoted. No member of the house has died in the business, but each one has in his turn withdrawn in season to enjoy the fruits of his industry.

THE MENTOR. By ALFRED AYRES. New York: Funk & Wagnalls. Pp. 211.

THIS little book, by an author already well known by his "Orthoëpist," "Verbalist," etc., is intended "for the guidance of such men and boys as would appear to advantage in the society of persons of the better sort." As the author well says, not wealth, but moral worth, supplemented with education, and enough money to make one's self presentable, are the passport to the better circles of society. In the body of the work are given common-sense principles respecting what constitutes a good personal appearance and good behavior—at the dinner-table, and in public, in conversation, in calls, and at cards, "odds and ends," and "What is a Gentleman?"

THE NEXT STEP OF PROGRESS: A LIMITATION OF WEALTH. By JOHN H. KEYSER, 115 Beekman Street, New York. Pp. 50. Price, 20 cents.

THIS document expounds the principles of a new party which has been formed, or is in the process of formation, of which the author appears as one of the active organizers. It proposes to "level up, not down," and to break monopoly by promoting a limitation of wealth. For this purpose, it would impose a graduated taxation on accumulating and accumulated fortunes, ranging, say, from one half of one per cent on estates of between $10,000 and $20,000, to fifty per cent on estates of $5,000,000 and upward.

SCHOOL-KEEPING. How to do it. By HIRAM ORCUTT. Boston: N. E. Publishing Company. Pp. 244. Price, $1.

THIS volume embodies to a great extent fruits of the author's experience; incidents that have happened during his school-keeping, and the thoughts and principles that have been suggested by them. Its design is to aid and encourage teachers who need and would profit by the experience of others; and to awaken an interest in the subjects treated, and lead to a more extensive reading and study of the works of standard authors on pedagogics, with a more careful preparation for the important duties of their position. It is a pleasant book, and contains good thoughts.

DILUVIUM: OR, THE END OF THE WORLD. By GEORGE S. PIDGEON. St. Louis: Commercial Printing Company. Pp. 175, with Plates.

THE author's purpose in publishing this book is to invite consideration of the possible consequences that may follow the execution of such a project as the French one for turning the waters of the ocean into the Desert of Sahara, and forming a great inland sea there. He apprehends that the sudden transfer of so large a mass of matter

from one part of the earth's surface to another will be attended with a disturbance of the center of gravity of the planet, and with convulsions, floods, and great disasters to the continents and what is upon them. Further, "meteorological, electrical, and other phenomena of equal greatness, grandeur, and sublimity, as those of land and water, would follow a paroxysmal movement of the earth." Therefore, it will be well to halt before making real so rash a scheme.

INGGLISH AZ SHE IZ SPELT. Perpetrated by Fritz Federheld. New York: G. W. Carleton & Co. Pp. 93. Price, 25 cents.

THE compiler of this odd composition evidently regards the accepted English orthography as a fetich to whose sanctity he does not consider himself bound to pay any respect; for he holds it up to ridicule in a very amusing style by parodies, epigrams, comic poems, anecdotes, and witty extracts, the purport of all of which is to stamp the whole system as inconsistent with itself, and particular features of it as absurd. The variety of the sounds which are given to the groups of letters "ough" is humorously set forth in several pieces, the most noteworthy of which is Planché's squib on the pronunciation of the name of Lord Houghton. Other rhymes, drawn from Professor Barnard, Professor Gregory, and others, expose what appear to be monstrosities of spelling, but which are shown to be justified by analogous spellings in other words recognized as orthographic. A series of extracts from standard authors shows what was the condition of English spelling, at intervals of about fifty years, from Chaucer to Samuel Johnson.

PRACTICAL WORK IN THE SCHOOL-ROOM. OBJECT-LESSONS ON THE HUMAN BODY. New York: A. Lovell & Co. Pp. 157.

THIS volume embraces transcripts of lessons that have been given in the primary department of Grammar-School, No. 49, New York, and which include instructions consonant with the plan, on the subject of physiology and the effects of stimulants and narcotics. The plan of teaching comprises a model lesson, to show how each subject should be developed and taught; a formula, embodying the principal facts presented; questions on the formula; directions for touching, or pointing to the part under description; questions on the lesson; and a blackboard outline.

ALICE'S ADVENTURES IN WONDERLAND, AND THROUGH THE LOOKING-GLASS. By LEWIS CARROL. New York: Macmillan & Co. Pp. 192 and 224, with 92 Illustrations. Price, paper, 50 cents; cloth, 75 cents.

Two books in one, of pure nonsense and delightful absurdities, which have for several years enjoyed extensive popularity. In the first book, Alice goes down into a rabbit-hole and has stirring adventures with the rabbit and an animated pack of cards. In the second story, she succeeds in getting into the country behind the looking-glass, where she finds everything reversed, and meets the characters of Mother Goose and English folk-lore mythology.

SERAPIS. By GEORGE EBERS. From the German by CLARA BELL. New York: William S. Gottsberger. Pp. 387. Price, 90 cents.

THIS is a story of Alexandria in A. D. 391, under Roman rule; one of those attempts to restore and present to the present age the life of antiquity, with some of the most successful of which the author's name is associated.

THE WANE OF AN IDEAL. By LA MARCHESA COLOMBI. From the Italian by CLARA BELL. New York: W. S. Gottsberger. Pp. 260. Price, 90 cents.

A STORY, by a popular living Italian novelist, of contemporary village life in the north of Italy, in which "a variety of the social problems which occupy Italian thought are treated in a way which is humorous without being cynical," and having a close "which is melancholy but scarcely tragical."

THE CANADIAN RECORD OF SCIENCE. Vol. I, No. 1. Quarterly. Pp. 64. Price, $3 per volume of eight numbers.

THIS journal takes the place of "The Canadian Naturalist and Geologist," and is under the charge of an editing committee of the Natural History Society of Montreal, which is composed of T. Sterry Hunt, D. P. Penhallow, B. J. Harrington, J. Wanless, and J. T. Donald. The intention of the editors is to present both original and se-

lected articles, more particularly those of especial interest to the Dominion. In the present number we find a history of the journal of which this is a continuation; an account of "The Royal Society of Canada"; a paper by Professor Dawson on "Rhizocarps in the Palæozoic Period;" a description by the Rev. Émile Petitot of "the Athabasca District of the Canadian Northwest Territory"; and shorter papers.

"SHADOWS": Being a Familiar Presentation of Thoughts and Experiences in Spiritual Matters, with Illustrative Narratives. By JOHN WETHERBEE. Boston: Colby & Rich. Pp. 288.

THE author's endeavor has been to give, in a series of chapters, each of which shall be a finished one of itself, the reasons, without particularly saying so, why he is a spiritualist; or to make a familiar presentation of the subject of modern spiritualism to those whom it may concern, both among its exponents, and among that wider world who feel interested in the subject, "and wish it were true," and want the "bottom facts."

MARYLAND'S INFLUENCE UPON LAND CESSIONS TO THE UNITED STATES. With Minor Papers. By HERBERT B. ADAMS, Ph. D. Baltimore: N. Murray. Pp. 102. Price, 75 cents.

THIS essay constitutes the first number of the third series of "Johns Hopkins University Studies in Historical and Political Science"—a series which is to be devoted to American institutions and economics. Among the purposes the author endeavors to serve in publishing it is to "call attention to the territorial foundations of the American Union, and point out the fact that our public lands stand in the same fundamental relation to our national commonwealth as did common lands to the village republics of New England. The great West was the *Folkland* of the United States; it bound them together by economic interests when they would otherwise have fallen apart after the Revolution. To trace out the further constitutional influence of our public lands upon the development of these States, which have increased and multiplied within the national domain, as did New England parishes within the original limits of one town, this would be a contribution indeed to American institutional history." As bearing upon this point, the author outlines a wide and varied field of research, on which it is hoped laborers will soon be engaged, and parts of which are to be exploited in future numbers of this series. The "Minor Papers" include articles on "George Washington's Interest in Western Lands," the "Potomac Company," and a "National University."

EGYPT AND BABYLON, FROM SACRED AND PROFANE SOURCES. By GEORGE RAWLINSON. New York: Charles Scribner's Sons. Pp. 329. Price, $1.50.

THE Bible abounds in references to Egypt and the Mesopotamian empires and their affairs. So long as we had to depend for our knowledge of those countries in ancient times from the statements, generally half informed and often erroneous, of the Greek historians, these references were obscure and difficult to verify. The progress of archæological discovery has put a different face upon matters. Under its light the life and history of these extremely ancient empires have been revealed at many points with remarkable vividness and a precision which we have hardly yet attained concerning some contemporary people, and the references in the Bible have been, to a very large extent, endowed with an exact significance. It is hardly necessary to say that further elucidations on points that are still dark may be anticipated from continued researches. It has been Mr. Rawlinson's task to collect the references, separately for Egypt and for Babylon, in the Bible, taking them nearly in chronological order, and to compare them with the facts, as related in other histories, and as inscribed in contemporary records, on the monuments executed by the rulers and peoples of the empires to which the references are made.

VAN NOSTRAND'S ENGINEERING MAGAZINE. Vol. XXXI, July–December, 1884. New York: D. Van Nostrand. Pp. 524.

THIS publication has a place of its own. It appeals especially to engineers, and to persons who are interested in the construction of works beyond the sphere of ordinary builders, and in extensive applications of machinery; and its papers on subjects of

such class, both original and selected from foreign journals, are, as a rule, written by experts, by men who have made special study of the points they are discussing, or have had experience in the application of them. It also pays considerable attention to topics of a more general scientific character, and gives much withal that commends itself to persons who are not specialists or professionally informed, but who have an intelligent interest in the progress of the departments to which it is devoted.

PROPOSED PLAN FOR A SEWERAGE SYSTEM, AND FOR THE DISPOSAL OF THE SEWAGE OF THE CITY OF PROVIDENCE. By SAMUEL M. GRAY, City Engineer. Pp. 146, with Plans and Maps.

CITY ENGINEER GRAY was deputed by the City Council of Providence, a year ago, to proceed with his assistant to Europe to investigate the various plans in practical operation for the disposition and utilization of sewage, and upon the information thus obtained to report a plan for adoption in that city. The list of cities and works he visited, in England, Wales, Holland, France, and Germany—wherever, in fact, important sewerage-works have been undertaken, or systems for the disposition of sewage have been tried, or are under trial—shows that his inspection was a busy one. In the plan which he has devised, with the aid of these observations, he has had in view the principle which is in reality the Hamlet of the question, but is too often left out, that "no system of sewerage is complete which fails to dispose of the sewage so as to avoid its causing a nuisance." The report embodies a large mass of information, presented with commendable brevity. After an historical review of the subject, the several systems for disposing of sewage are considered as to their general principles and specifically. Among these are the systems of sewage interception, or dry-sewage systems, the pneumatic systems (Liernur, Berlier, and Shone); the water-carriage system; and the systems of disposal by irrigation and precipitation; with a comparison of the different methods of purifying sewage. Although prepared only for a special object, the report might, in the absence of any other comprehensive work, serve as a general manual of the subject.

TABLES, METEOROLOGICAL AND PHYSICAL. By ARNOLD GUYOT. Fourth edition, revised and enlarged. Edited by WILLIAM LIBBEY, Jr. Washington: Smithsonian Institution. Pp. 738.

PROFESSOR GUYOT'S original work, published in 1852, was the first of the series of "Tables of Constants," to which the Smithsonian Institution is gradually making important contributions, and has proved, by the demand which arose for it, to be the one of the series that has met the most general public want. A second revised edition was published in 1857, in which the tables were so enlarged as to extend the volume of the book from two hundred and twelve to more than six hundred pages. A third edition was published in 1879, with further amendments. The author began the revision for this fourth edition in 1879, but was met with delays, and died before completing the work, which was left for his assistant and successor in his college professorship to finish. The contents consist of tables comparing the different thermometrical scales, with reductions from one to another; hygrometrical tables, with tables for the conversion of metrical hygrometric measures into others; barometrical tables; hypsometrical tables; geographical measures, in which means are given for reducing the measures of all countries from one to another; meteorological corrections; and "Miscellaneous Tables useful in Terrestrial Physics and Meteorology." The whole constitute a valuable reference-book.

THE ORNITHOLOGIST AND OÖLOGIST, Vol. IX. 1884. Pawtucket, R. I.: Frank B. Webster, publisher. Twelve Numbers. Pp. 152. Price, $1.50 a year; 15 cents a number.

AS is implied in its title, this is a magazine devoted to birds, their nests, and eggs. It is beautifully printed, and is sustained by a corps of competent and enthusiastic contributors, who record in it their daily, weekly, monthly, yearly, or occasional observations, on these the most attractive of man's companions on the earth. It is a pity that so many of them consider it an indispensable preliminary to the observations to shoot the birds or steal their eggs. In the present state of science, these things, when they are done, are unnecessary in nine cases out

of ten. Except for the encouragement given to this practice, which is reprehensible, except when most sparingly and discriminatingly indulged in, we cordially recommend the "Ornithologist and Oölogist" as a publication that every lover of Nature will do well to have by his side. It also admits to its pages notes and observations on the kindred study of entomology.

OUR BODIES; OR, HOW WE LIVE. By ALBERT F. BLAISDELL, M. D. Boston: Lee & Shepard; New York: Charles F. Dillingham. Pp. 285. Price, 60 cents.

THIS is a "Physiology for the Young," intended for an elementary text-book in the common schools. It aims to present clearly, concisely, and in a logical order, the most important facts about the build and health of our bodies. Prominence has been given to such facts of anatomy and physiology as are essential to a proper understanding of the laws of hygiene. Hence, special emphasis has been laid upon the practical bearing of this branch of science upon daily life and personal health. As far as possible, each paragraph is complete in itself, and discusses a definite subject. The instructions of the text are re-enforced by review and analytical chapters, and by a systematic series of practical and suggestive experiments, simple and not requiring expensive apparatus.

STORIES BY AMERICAN AUTHORS. IX. New York: Charles Scribner's Sons. Pp. 180. Price, 50 cents.

IT was a happy thought to gather up into this series of volumes, convenient to hold in the hand or to put in the pocket, the fugitive short stories that have appeared from time to time in various publications; many of them, perhaps, by authors whose works would never have been otherwise collected. To say nothing of their interest as stories, these works are of value—if we may judge from the present volume—as giving pictures of American character and life in various situations, with bright local coloring. One of the stories pictures a Virginia neighborhood before the war; another gives a piece of the life of a New England seaport village; a third offers a view of a California village, with its political boss; and another is a sailor's yarn, told in his own dialect.

PUBLICATIONS RECEIVED.

Should Experiments on Animals be restricted or abolished? Pp. 18. Methods of studying the Physiological Action of Drugs. Pp. 20. Death. Pp. 5. All by Robert Meade Smith, M. D. Detroit: George H. Davis.

"The Pulpit of To-Day." A monthly magazine of sermons. Alfred E. Rose, Editor, Westfield, N. Y. New York: Fords, Howard & Hulbert. Pp. 58.

The Thermic Phenomena in Contraction of Mammalian Muscles. By Robert Meade Smith, M. D. New York: G. P. Putnam's Sons. Pp. 50.

The Truth-Seeker Annual and Free-Thinkers' Almanac, for 1885. New York: Truth-Seeker Office, 88 Clinton Place. Pp. 120. 25 cents.

A Correction of Certain Statements published in "The Zoöphilist." By H. Newell Martin, M. D., Baltimore. Pp. 11.

The New Departure in College Education. By James McCosh, President of Princeton College. New York: Charles Scribner's Sons. Pp. 28. 15 cents.

U. S. Department of Agriculture. Report of the Entomologist, for 1884. By Charles V. Riley. Washington: Government Printing-Office. Pp. 144, with Ten Plates.

Report on the Waters of the Hudson River. By C. F. Chandler, Ph. D. New York: Trow's Printing and Bookbinding Company. Pp. 35.

"The Journal of Physiology." Edited by Michael Foster, M. D. Vol. V, Nos. 4, 5, 6. Cambridge, England. Baltimore: Professor H. Newell Martin. Pp. 180, with Plates. $5 a volume.

Alabama Weather Service. February, 1885. Auburn, Ala.: Agricultural and Mechanical College. Pp. 15.

Medical Jurisprudence in Divorce. By Carl H. von Klein, M. D., Dayton, Ohio. Pp. 8.

A General Description, etc., of the Cotton-producing States. By Eugene A. Smith, Ph. D. Tuscaloosa, Ala. Pp. 80, with Maps.

Septennial Report of Ligonier Public Schools, Indiana. Pp. 89.

Supplement to the Transactions of the Sei I Kwai, or Society for the Advancement of Medical Science in Japan. "Transactions" Monthly. Tokio. Pp. 16 English—40 Japanese. $2 silver a year.

Ten Days in the Laboratory with Dr. Robert Koch, of Berlin. By George W. Lenois, Jr. Buffalo, N. Y. Pp. 15.

Mind in Nature. Vol. I, No. 1. Monthly. Chicago: Cosmic Publishing Company. Pp. 16. 10 cents a copy; $1 a year.

A Synopsis of the Medical Botany of Illinois. By J. M. G. Carter, M. D., Waukegan. Pp. 45.

The Progress of the Working-Classes in the Last Half-Century. By Robert Griffen. New York: G. P. Putnam's Sons. Pp. 43. 25 cents.

The Osteology of Amia Calva. By R. W. Shufeldt. Pp. 182, with Fourteen Plates.

The Action and Antagonism of some Drugs on the Frog's Ventricle. By Thomas J. Mays, M. D. Philadelphia. Pp. 17.

Sorghum, its Culture and Uses. By Dr. Peter Collier. New York: Chamber of Commerce. Pp. 20.

"The Cornell Review," March, 1885 (Woodford number). Pp. 28.

An Electric Ophthalmoscope. By Louis J. Lautenbach, M. D., of Philadelphia. Pp. 7.

New York State Board of Health. Monthly Bulletin, February, 1885. Pp. 2.

Science and the Supernatural. By Professor A. J. Dubois, New Haven. Pp. 32.

Defective and Corrupt Legislation, The Cause and the Remedy. By Simon Sterne. New York: G. P. Putnam's Sons. Pp. 26. 25 cents.

A Hand-Book on the Teeth of Gears. By George B. Grant. Boston. Pp. 29. $1.

U. S. Bureau of Entomology. Catalogue of New Orleans Exhibit of Economic Entomology. Washington: Judd & Detweiler. Pp. 95.

A Solution of the Mormon Problem. By John Codman. New York: G. P. Putnam's Sons. Pp. 25. 25 cents.

"The Alumni Magazine" (Lincoln University). Philadelphia: 924 Lombard Street. Quarterly. Pp. 24. 30 cents a number, $1 a year.

International Electrical Exhibition, 1884. Reports of Examiners: XIX, Electric Telegraphs, pp. 24. XXIV, Electro-Dental Apparatus, pp. 11. XXVII, Applications of Electricity to Warfare, pp. 8. With Plates. Philadelphia.

New York State Reformatory. Report of the Board of Managers, 1884. Elmira. Pp. 100.

Local Institutions of Virginia. By Edward Ingle. Baltimore: N. Murray. Pp. 127. 75 cents.

International Fisheries Exhibition. Report upon the American Section. By G. Brown Goode. Washington: Government Printing-Office. Pp. 1,279.

Man's Birthright; or, The Higher Law of Property. By Edward H. G. Clark. New York: G. P. Putnam's Sons. Pp. 183. 75 cents.

Madam How and Lady Why. By Charles Kingsley. New York: Macmillan & Co. Pp. 321, 50 cents.

Mind-Reading and beyond. By William A. Hovey. Boston: Lee & Shepard. New York: C. T. Dillingham. Pp. 201. $1.25.

Obiter Dicta. New York: Charles Scribner's Sons. Pp. 232. $1.

The History of the Present Tariff, 1860-1883. By F. W. Taussig, Ph. D. New York: G. P. Putnam's Sons. Pp. 111. 75 cents.

Jelly-Fish, Star-Fish, and Sea-Urchins. By G. J. Romanes. New York: D. Appleton & Co. Pp. 383. $1.75.

Geology and the Deluge. By the Duke of Argyll. Glasgow: Wilson & McCormick. Pp. 47.

Paradise Found. By William F. Warren, S. T. D. Boston: Houghton, Mifflin & Co. Pp. 504. $2.

The Lenápé and their Legends. By Daniel G. Brinton. Philadelphia: D. G. Brinton. Pp. 262.

The "Quincy Methods" illustrated. By Lelia E. Partridge. New York: E. L. Kellogg & Co. Pp. 660. $1.50.

The Rescue of Greely. By Commander W. S. Schley and Professor J. R. Soley. New York: Charles Scribner's Sons. Pp. 277, with Maps. $3.

The Ten Laws of Health. By J. R. Black, M. D. Baltimore: J. R. Black, M. D. Pp. 418. $2.50.

The Life of Society. By Edmund Woodward Brown. New York: G. P. Putnam's Sons. Pp. 270. $2.

Contributions to American Ethnology. Vol. V. U. S. Geographical and Geological Survey. Washington: Government Printing-Office. Pp. 237, with Plates.

The Cretaceous and Tertiary Floras of the Territories. By Leo Lesquereux. Washington: Government Printing-Office. Pp. 288, with Fifty-nine Plates.

U. S. Geological Survey. Third Annual Report. J. W. Powell, Director. Washington: Government Printing-Office. Pp. 564, with Plates.

Geology of the Comstock Lode and the Washoe District. By George F. Becker. Washington: Government Printing-Office. Pp. 422. Atlas to accompany the same, 21 sheets and Maps.

The Religion of Philosophy, or the Unification of Knowledge. By Raymond S. Perrin. New York: G. P. Putnam's Sons. Pp. 566. $4.

Dinocerata. A Monograph of an Extinct Order of Gigantic Mammals. By Othniel Charles Marsh. Washington: U. S. Geological Survey. Pp. 237, with Fifty-six Plates.

POPULAR MISCELLANY.

Fifty Years of the Essex Institute.—Professor E. S. Morse has published a review of the condition of zoölogy fifty years ago and to-day, in connection with the growth of the Essex Institute, which has just completed its first half-century. The institute has always kept true to its name. It has been wholly for the benefit and in the interests of the county of Essex, in every corporate town of which but one public meetings have been held, to the number of two hundred in all; while the enthusiasm of its members has often led it beyond the limits of the county and of the State, into, in all, some sixty-eight "out-of-the-way places—little villages, cross-roads, and hamlets by the sea." To these places the society has induced the celebrated naturalists of the country to bring the results of their researches, and the latest and freshest fruits of science. Further evidence of its county character is found in the facts that its members are scattered over the county, and that it has aimed especially at forming a collection of the animals and plants of the county, and has such a collection, which is not excelled by any other of similar character. When the Institute was founded, there was not a single text-book of zoölogy in our schools; now, every high and classical school has its classes in zoölogy and botany, and every college its special professor. Then there was not a single popular periodical devoted to those sciences; now there are a number of illustrated weeklies and monthlies with a large circulation, the earliest of them, the "American Naturalist," having been founded under the auspices of the Institute; and even the newspapers keep pace with the progress of science, and publish special articles on scientific matters of interest. Then, the science of archæology was not born; now it is 'the most vigorous and aggressive of the sciences," and one of the Institute's men, Mr. Putnam, "is, for the first time, teaching the country the proper and only way of exploring the mysterious mounds of the West." The little society of a few men and a library of a hundred volumes has grown to be a powerful body of three hundred and forty members, with a library of thirty-eight thousand volumes.

Why Wool felts.—The cause of the felting properties of wool is generally attributed to serratures on the surface of the fibers, which are supposed, when driven into the closest possible contact, to hook into one another, and so to hold together by what might be called a "beggar's-lice grapple." The validity of this theory was called into question by two gentlemen of Hartford, Captain George R. Case, a microscopist, and Mr. Joseph Dawson, a woolen manufacturer. These gentlemen, obtaining samples of wool of different grades, subjected them to various manipulations, and found: 1. That a single fiber of wool, when manipulated by itself in a lubricant of soap, has no fulling property, but rather a tendency to lengthen the fiber; 2. That a number of fibers placed side by side, just as they grew on the sheep, and with simply tension enough to take out the kinks, when manipulated with a lubricant of soap, have no felting property; 3. That fibers similarly treated, but with the roots and tips alternating, have no fulling or felting property, and no power of adhesion; but, 4. That a number of fibers placed side by side, with the tips all one way or with the roots and tips alternating, without any tension, have fulling properties; and, 5. That fine-carded wool, taken from a second breaker, with the fibers thoroughly mixed, has great fulling properties when properly manipulated. A sample of negro's hair of suitable length, which was found by microscopical examination comparatively free from serratures but slightly spiral in structure, manipulated in the same manner as the wool had been, was formed into a "well-felted sample of cloth." These and other experiments satisfied the authors that the fulling properties of wool or any other fibers were in proportion to the number of waves, curls, or kinks, and their degree of fineness, and that the serratures, *per se*, have little to do with the matter, excepting possibly that which may be due to friction. "To the question, What is the cause of the fulling or felting of wool? the simplest answer possible is, it is the looping and interlooping, locking and interlocking of the fibers until they become inextricably entangled, but by interlooping and interlocking, and not upon the beggar's-lice principle."

Spade-Foot Toads.—Dr. Charles C. Abbott contributes to the "American Naturalist" a study of the hermit spade-foot toad (*Scaphiophis Holbrooki*), a rare animal, whose custom it seems to be to appear unexpectedly in numbers, and, after a few days, suddenly to disappear. Its name is derived from its long, horny index-toe, which may well be characterized as a spade, for it digs with it rapidly into the ground; and its voice, immense for so small an animal, is like a steam-whistle. The spade-foots first visited Dr. Abbott's field of observation in May, 1874, stayed a few days, and were gone. Their next visit, ten years having passed without a single specimen being seen or heard, was April 10, 1884, in the same spot, a sink-hole in a dry upland field near Trenton, N. J. They remained till the 15th, when the weather became cooler and they vanished. Again they came, June 26th, after a rain-storm that flooded the sink-hole, and were found sitting on the grass-tufts and swimming in the pond by the hundred, all uttering their shrill, ear-piercing groans, through the day and night; but on the morning of the 28th all were gone. During this brief visit the frogs spawned, and the eggs were found attached to blades of grass and slender twigs. In about a week, those of them which were not destroyed by the retiring of the water were hatched out into tadpoles very much like other tadpoles. As they grew, about five per cent of the number failed to develop as rapidly as the others. These "retarded" tadpoles were voracious cannibals, preying upon their fellows, now become "hoppers" and miniatures of the adult spade-foots, so extensively that it was necessary to protect them to save any. In due time, the water was removed from the aquarium, and earth put in its place to about an inch in depth. "Upon this the young spade-foots were placed, and in less than one minute many had commenced digging little burrows, into which they disappeared as the excavations deepened. . . . In twenty minutes all but two of forty-four specimens were below the surface." A few individuals remained in the sink-holes as the water dried up into puddles; but Dr. Abbott having neglected them, under the supposition that they would burrow where they were, for ten days, could find

no trace of them upon an exhaustive search. He concludes that the animals must wander farther from their breeding-grounds than is supposed, or else must dig far deeper into the earth than to six or eight inches, as stated by Holbrook and De Kay.

Effect of Earthquakes on Buildings.—Mr. John Milne, of Tokio, Japan, has published some observations of the effects of earthquakes on buildings. In regard to the relative security of buildings on low and on high ground there is no universal rule, but each small area in an earthquake-region has its peculiarities. Theory indicates that soft, marshy ground is safer, because it will act as a buffer between the shock and the building; and the Temple of Diana, at Ephesus, was located with reference to this point. But experience at Tokio and Manila has shown repeatedly that there is very little, if anything, in it; and hard, rocky strata, where the amplitude of motion is small, but the period quick as compared with the motion in the inelastic material of the plains, proved the better foundation in Jamaica in 1692, and at Lisbon in 1755. Places to be avoided are the edges of cliffs, scarps, and cuttings. Europeans fasten the foundations of their buildings firmly in the ground, and their houses are much shaken. The Japanese put their structures loosely on top of stones or bowlders, and they escape serious disturbance. Europeans and Americans build iron-bound houses to resist earthquakes, and they resist them, though they get badly shaken, as a steel box would be; but they are very expensive. The Japanese and the people of the west coast of South America build a kind of wicker-basket house—a frame house with a light roof, which lives through the earthquake like "a reed shaken by the wind." The stability of such houses depends upon their not being firmly attached to the earth, and their numerous joints admit considerable yielding, so that the earthquake-wave passes through them before they begin to show its visible effects. A cheap aseismic house would be a low frame building supported by a number of slightly concave surfaces resting on segments of stone or metal spheres in connection with the ground. Chimneys should be given a play-space around them, and not be in contact with the roof; else, since the vibrational periods of the chimney and the roof never correspond, clashes will occur between them, and a shock and overthrow result. The pitch of the roof should not be great, or the tiles or slates will be shot off; and the upper parts of all buildings should be as light as is consistent with strength.

Suggestions in School-keeping.—Mrs. H. F. Wilson, in a paper read before the Educational Association of Alabama, tells how in her school she eschewed the system of marks and statistical reports as pernicious and false, and imposed as the one rule to govern the whole school, "Do right"; and, as the real goal to be reached, excellence in everything. Incorrect sentences heard by any pupil are reported in a blunder-box, to be corrected by the school. Once a week, half an hour is devoted to the recitation of facts, drawn from the public press and other sources. Half of every holiday is given to microscopic, stereoscopic, or other instructive exhibitions. In connection with the teaching of music, information is collected concerning the old masters of music. Physical culture is attended to, and dancing is cultivated as an element of it. In this work the teacher finds infinite variety and enjoyment, and has been "filled with amazement and enthusiasm at the immense amount of work pupils did unbidden, hunting over cyclopædias and books of reference for information when the text-book was obscure or inadequate."

Source of Atmospheric Electricity.—The source of atmospheric electricity has never yet been satisfactorily indicated, although various theories have been suggested to account for it. It has been attributed to aërial friction, to combustion or oxidation, to evaporation, and to condensation, to inductive or conductive effects of the earth's electricity, to convection currents, to electrified corpuscles coming from the sun, to solar radiation, to the friction of aqueous vapor against dry air, to capillary surface-tension of water, to the production of hail, etc. Professor Tait suggests that the mere contact of the particles of vapor with the air may suffice to produce the exceedingly small potential requisite to start the effects. He

has not had an opportunity to investigate his hypothesis, but he makes a few statements that illustrate how apparently small this potential may be. "To raise a single pound of water," he says, "in the form of vapor from the sea or from moist ground, requires an amount of work equal to that of a horse for about half an hour. This is given out again, in the form of heat, by the vapor when it condenses; and the pound of water, falling as rain, would cover a square foot of ground to the depth of rather less than one fifth of an inch. Thus, a fifth of an inch of rain represents a horse-power for half an hour on every square foot; or on a square mile, about a million horse-power for fourteen hours. A million horses would barely have standing-room on a square mile. Considerations like this show that we can account for the most violent hurricanes by the energy set free by the mere condensation of vapor required for the concomitant rain. Now, the modern kinetic theory of gases shows that the particles of water-vapor are so small that there are somewhere about three hundred millions of millions of them in a single cubic inch of saturated steam at ordinary atmospheric pressure. This corresponds to $^1/_{1600}$ or so of a cubic inch of water—i. e., to about an average rain-drop. But if each of the vapor particles had been by any cause electrified to one and the same potential, and all could be made to unite, the potential of the rain-drop formed from them would be fifty million million times greater. Thus it appears that if there be any cause which would give each particle of vapor an electric potential, even if that potential were far smaller than any that can be indicated by our most delicate electrometers, the aggregation of those particles into rain-drops would easily explain the charge of the most formidable thunder-cloud."

How an Iron-Ore Bed was formed.—Professor James P. Kimball, of Lehigh University, has published in a single pamphlet two papers on the iron-ores of the Juragua Hills, of the province of Santiago, Cuba, beds of a hematite or specular ore, which appears to be largely the result of the weathering of the highly basic rock which gives the geological character of the formation. These rocks, the eruptive material which gave origin to the iron-ore, consisted of proto-silicates, or silica combined with the protoxide bases, iron, lime, and magnesia, and with alumina. Under its new conditions at and near the surface, with access to oxygen in the atmosphere, circulating waters, etc., the protoxide of iron became rapidly further oxidized into ferric or sesquioxide, which is a comparatively stable product under conditions prevailing at the surface. The oxidation of the ferrous to ferric oxide is attended with more or less complete dismemberment of the eruptive rock, little by little. Silica originally combined with the ferrous oxide is isolated as silica. Silicates of lime, magnesia, and alumina form new aggregates among themselves. Soluble matter as fast as isolated enters into solution in circulating waters, and is thus at hand to assist in the work of weathering. This work of alteration has gone on until a complete change has been wrought not only in the composition but also in the arrangement of the original eruptive rock. By the law of molecular attraction a process of concentration has gone on simultaneously with the process of weathering decay. Homogeneous material, such as ferric oxide, was collected by itself to a degree far greater than the other earthy residues, because, in the process of conversion from ferrous to ferric oxide, it has been in solution, and so in circulation, and has hence become finally deposited under long-prevailing conditions of uniform circulation. The process here briefly followed out has gone on just below the surface, within the range of the circulating waters. The same action immediately at the surface is followed by waste or diffusion of the products of alteration. In the present case, the best of the ore-bodies are mainly, if not indeed wholly, replacements of coralline limestone.

Jules Verne as a Scientific Authority.—The "Revue Scientifique" discusses a curious question in giving its estimate of the value of Jules Verne as a scientific writer. It considers the judgment, which many of us are ready to give, that such science as is inserted into the framework of a romance is worse than no science at all, as too severe.

"Does any one believe seriously that a cannon-ball can be shot from the earth to the moon? But what harm is there in letting a child entertain a fancy of the kind for a few hours? He amuses himself with it, and, while he is amused, he learns, without conscious effort, that the moon revolves around the earth, and the earth around the sun, and that there are forces of gravitation and universal attraction, etc. . . . The false idea does no harm, for nothing is built upon it. . . . I venture to say that it is advantageous to inspire children with the love of hazardous adventures, and the taste for the unknown that they find in all the romances of Jules Verne. They will encounter real difficulties soon enough to be discouraged from them earlier than they need to be. Not to see the difficulties is sometimes a good way to triumph over them. We have all grown timid and hesitating, and it is not a bad thing for us to be roused up to ardor in chimerical enterprises, in which the power of science is exhibited to us in the service of an energetic will. It is, perhaps, on this account, as much as for the amusement they give us, that we avow a strong liking for all of M. Verne's works. We might, if it were worth while, defend M. Verne on other considerations. When an idea enters the mind of a child, what matter is it how it gets there? Whether it be in a romance, or in a lesson, or in a text-book, or in a familiar conversation, makes but little difference, so the result is acquired. To tell a fourteen-year-old boy that the diamond is crystallized carbon, and that fruitless efforts have been made to produce it artificially, is all very well, but will he remember it? Are these abstract facts interesting enough to stay? Possibly; but the contrary is probable. When you interest a child by relating to him the adventures of Cyprian, as he puts earth and charcoal into a crucible, and tries to crystallize it into a diamond, the scientific fact will not be forgotten; and some day Cyprian will retire into the background, while the physical fact will be a permanent acquisition, which he will owe to this new mnemonic agency. It is more than mnemonics. While M. Verne entertains us with adventures, and fastens scientific facts upon us, he also gives us a taste for science. With him it is a goodly personage, smiling, affable, pleasant, greeting all who come."

Crickets and "Hair-Snakes."—The so-called horse-hair snake, as is known to naturalists, is a parasite of the cricket, which only becomes active under water. Dr. H. C. McCook recently read a statement before the Academy of Natural Sciences of Philadelphia which indicates that the crickets are aware of the peculiarity of their parasites, and take advantage of it to get rid of them. A lady having moved into a house which was a harbor for crickets, was troubled by frequently finding the hair-snakes in her water-pails, a short time after the water had been brought into the house. She sat down to watch how they came there. In a short time she saw "a particularly plethoric cricket" mount upon the edge of the pail, and, after some uneasy movements, bring the tip of the abdomen just beneath the water, and, with a few violent throes, expel a black mass, which fell slowly through the water, and, before it reached the bottom, resolved itself into one of the worms. The cricket seemed much exhausted by the operation.

Toxic Effects of Smoking.—Dr. Zulinski, of Warsaw, has made some experiments upon the effects of tobacco-smoke, which he determined to be a distinct poison, even in small doses. Its action on men is very slight when it is not inhaled in large quantities, but it soon becomes powerful in those who contract the habit of "swallowing the smoke." The toxical property is not due exclusively to the nicotine, but the smoke, even when disengaged from nicotine, contains a second toxical principle, called solanine, besides carbonic oxide and hydrocyanic acid. The effects produced by smoking depend upon the nature of the tobacco and the way in which it is smoked. The cigar-smoker absorbs more poison than the cigarette-smoker, and he than the person who smokes a pipe; while the one who uses a medium, by which the smoke is conducted through water, reduces the deleterious effects to a minimum. As a rule, the light-colored tobaccos are supposed to be the mildest, but they are sometimes artificially uncolored by chemicals, the presence of which is danger-

ous. Tobaccos are also generally adulterated, and, if the adulterating matter be woody, the smoke will be of high temperature, and liable to cause inflammation of the tongue.

Antipathies.—Some strange cases of antipathy are recorded in the lives of eminent men. Erasmus was made feverish by the smell of fish. Ambroise Parr had a patient who would faint at the sight of an eel, and another who was convulsed on seeing a carp. Gardan was disgusted at the sight of eggs. A king of Poland and a secretary of France bled at the nose when offered apples. A huntsman in Hanover, who would attack a wild-boar valiantly, ran away or fainted whenever roast pig was presented to his view. A person is told of who fainted whenever he saw a rose, and similar stories are told of antipathies to lilies and honey. Tycho Brahe abhorred foxes, Henry III. of France cats, mice, spiders, etc., and Marshal d'Albret pigs. There was "once upon a time" a lady who could not endure the sight of silk or satin. The man who would faint whenever he heard a servant sweeping is not so much of a stranger, and the one who was similarly affected by the sound of a bagpipe invites universal sympathy. Boyle was overcome at hearing the splashing of water.

Coinage Alloys.—According to Professor W. Chandler Roberts, of the Royal Mint, the term alloy is usually applied in ordinary language to the mass formed by mixing a base metal with a precious one, while in scientific language it indicates the base metal which is added. Alloys are used in preference to pure precious metals for various reasons, chief among which is the fact that they are harder and more durable. The fact that their substitution for pure gold or silver may be a valuable source of revenue is a less commendable reason, but has not been without force. When a base metal is to be chosen for mixture with a precious one, it should be borne in mind that the resulting alloy must have the qualities of good color, ductility, and freedom from brittleness. Silver forms a very ductile alloy with gold, but lowers the color, while copper forms a durable as well as a ductile alloy and heightens the color. A triple alloy of gold, silver, and copper may be made of delicate tints; but it is difficult to assay and causes complications in the keeping of the accounts, and for those reasons the simple copper alloy is now almost universally used. At the mint, the qualities sought as most desirable in an alloy are: 1. Ductility; 2. Durability; and, 3. Uniformity of composition. The alloy is, besides, expected to be sonorous, or to impart the true "ring" to the coins struck from it, and to possess the degree of viscosity which will enable it to flow under pressure into all the fine lines of an engraved die, while at the same time the metal must be rigid enough to retain its impression when submitted to rough usage. A great variety of alloys have been used for coinage in the world's history, from pure precious metal down to base metal with only a trace of precious metal in it. Those now in use are not very numerous. The fineness of alloys of silver is computed with reference to the troy pound. The computation in the case of gold alloys is based on the singular "carat" system, the name of which is probably derived from the *κεράτιον*, a small Greek weight. This has within two years given way at the British Mint to a decimal system.

Making Champagne.—The making of champagne is a process requiring extreme care and attention at every stage for at least two years. The grapes are picked with especial pains to keep any of them from falling or receiving bruises. Only the juice of the first pressing is made into high-class wine, and the quantity of this that shall be drawn is regulated by weight. Four hundred kilogrammes are allowed for every forty gallons of wine, and when the desired quantity has been obtained the pressing is stopped. The protruding edges of the mass which have escaped the heavier pressure are cut off and subjected to a second pressure, the juice from which is called the first *taille*. A third pressure gives the second *taille*, and a fourth the *rebêche*, juices that are considered fit only for the workmen. When the scum has risen in the wine-tubs it is taken off, and the casks are filled and fumigated with sulphur and put away, not quite full, in the cellar, for fermentation.

The wine is racked off into other casks when the fermentation has subsided, and becomes quite clear by the time the December frosts set in. It is then mixed, by bringing together thirty or forty casks of the same growth, and blended. Tannin is added, to neutralize grease and deposits, and as much alcohol as is required. At a later stage a *masque* or deposit forms on the side of the bottle, the removal of which requires much care and skill and manipulation for several weeks. Afterward a sirup of sugar and alcohol is added, in proportions varying according to the country to which the wine is to be sent. Finally, the bottles are corked, wired, and set on end.

Changes in the Color of the Hair.—Cases of changes in the color of hair other than to gray are not uncommon. Workers in cobalt-mines and indigo-works sometimes have their hair turned blue, and workers in copper green, by deposition of coloring-matter upon it. This, however, is only a superficial coloring, and can be washed off. Prentiss records a case of a patient to whom muriate of pilocarpine was administered hypodermically whose hair was changed from light blonde to nearly jet-black, and his eyes from light blue to dark blue. These changes were due to increase of normal pigment. Hauptmann relates a case of a body exhumed twenty years after burial, the hair on which had changed from dark brown to red. Leonard cites a case in which, after death, red hair was changed to gray within thirty hours. Other cases have been mentioned in which the color of the hair has been variously changed in consequence of disease.

Decline of Mussulman Industries.—According to a letter in the "Allgemeine Zeitung," art and industry are in a lower stage in Algeria than in any other Mohammedan country, and their progressive decline is perceptible there from day to day. Persons may be seen walking in the streets of Algiers, dressed in Moorish or Arabian costumes, every piece of which is of European origin. Many branches of industry are extinct, others are nearly so, and all show unmistakable signs of decay. Many articles of European production are much cheaper than Mohammedan fabrics of the same kind, and are preferred for that reason; and many which at the first glance seem to be Mohammedan are in fact European imitations. Most of the really Mohammedan articles which are found, such as carpets, cloths, and table-wares, are not Algerian, but of Moroccan or Syrian manufacture. Arms are not made, for the wearing of them is forbidden by the French Government; but the Kabyles make a kind of iron knife, which can hardly be called a weapon. The only native industry still flourishing in the city of Algiers appears to be shoe-making, and this is because the Algerine men refuse to wear European shoes; but the women wear shoes of the prevailing fashion, with Louis XIV. heels. The cause of the depression of Mohammedan industry is the pressure of European population and influence, which has been attended with a corresponding diminution of the Turkish element.

Aryan Origins.—Professor K. Penka, of Vienna, has recently published a work on "Aryan Origins," in which, according to Professor A. H. Sayce, an eminent linguist, he sets out with "the incontrovertible but hitherto neglected doctrine that language alone will not interpret for us the former history of our race. Without the aid of anthropology, it is not only useless, but misleading. The theories built on the assumption that language and race are interchangeable terms, have introduced nothing but confusion into science, and have even left their scar on the politics of the day. It is only the skull in the hands of the anthropologist which can teach him the relationship of a people; the language they speak, or may have spoken, will of itself tell him but little." Professor O. Schrader has published, at Jena, a work regarding the Indo-Germanic race from the linguistic side, "in which," says Professor Sayce again, "for the first time a thoroughly critical method has been employed in determining the character and condition of primitive Aryan society by means of the records of speech; and the results are very different indeed from the idyllic picture of that civilized community to which Pictet and other writers have accustomed us. The early Aryan comes before us as a coarse and uncivilized

nomad, unacquainted with the use of metals, and protecting himself with the skins of wild beasts from the inclemencies of the climate." What his society was like, Professor Schrader thinks may be gathered from the remains left by the "pile-villagers" of the Swiss lakes, whom he regards as Aryans. Both Professor Penka and Professor Schrader express the belief that Europe, and not Asia, was the original home of the Aryan family. Penka considers the starting-point of Aryan emigration to have been Scandinavia, while Schrader suggests the northeastern lands of Europe generally as the most probable locality. The evidence, according to Professor Sayce, is now tending to show that the districts in the neighborhood of the Baltic were those where the race or races who spoke the Aryan languages originally dwelt, and that the Aryan invaders of Northwestern India were only a late and distant offshoot of the primitive stock who were speedily absorbed into the earlier population of the country as they advanced southward.

A Highway in the Himalayas.—One of the native explorers of the Himalayan regions of India lying beyond the British boundary, says Sir J. H. Lefroy, in his British Association address, "describes a portion of his track at the back of Mount Everest as having been carried for a third of a mile along the face of a precipice at the height of fifteen hundred feet above the Bhotia-kosi River upon iron pegs let into the face of the rock, the path being formed by bars of iron and slabs of stone stretching from peg to peg, in no place more than eighteen inches and often not more than nine inches wide. Nevertheless, this path is constantly used by men carrying burdens."

Currency of the Cannibal Islands.—Mr. Walter Coote has described some curious moneys of the New Hebrides and the Solomon Islands. On one of the islands he noticed a neatly-kept house, which he was told was the money-house. Entering it, he found a number of mats hanging from the roof, beneath which a fire was constantly kept up, under the effect of which they became covered with a black, glistening coating and adorned with festoons of soot. It was a man's business to keep the fire always burning, and so low as not to scorch the mats. A well-colored mat is worth about as much as a well-grown, vigorous boar. This is the strangest of all kinds of money, for it must never be taken from the money-house, even when the title in it is transferred from one owner to another. The inhabitants of Santa Cruz Island use for money rope-ends, about an inch thick, and ornamented with scarlet feathers, which are worn about the waist. The traveler could not obtain new coins of this kind, but found them current everywhere. The specimens he bought were already old, and the feathers grown dingy. The money of the Solomon Islands consists of neatly-worked pieces of shell of about the size of our shirt-buttons. They are strung on strings about four yards long, and are distinguished under the names of red and white money. Dog-teeth are of higher value, and comparable to our gold coins. They are usually worn on a string around the neck. Mr. Coote saw a necklace of this kind that was valued at about a hundred dollars. Marble rings are also worn on the breast for ornaments, and as valuable money. The currency-table of these islands would be about as follows:

10 cocoanuts = 1 string of white-money.

10 strings of white-money = 1 string of red-money, or 1 dog-tooth.

10 strings of red-money = 1 isa, or 50 dolphins' teeth.

10 isa = 1 fine woman.

1 bahika, or marble ring = 1 head with the head-antlers, or 1 good hog, or 1 useful young man.

Theory of Lubricants.—In a British Association paper on the theory of lubricants, Professor Osborne Reynolds referred to some experiments by Mr. Tower, which showed that, when the rotating journal with its box was immersed in a bath of the lubricant, the resistance was not more than one tenth of its value in ordinary oiling, and that the journal was less likely to heat at higher than at lower speed; and that if, after running the journal for some time in one direction, a reversal was made, great heating would result. This was to be ex-

pected, in the light of an observation made by Professor Reynolds, that there must result a difference of pressure on the two sides of the vertical line through the center of gravity in the thin space between the box and the journal—the maximum being on one side or the other, according as the rotation is one way or the other; for, undoubtedly, the box and journal became adapted to each other for a certain direction of running, and when a reversal was made some time would elapse before a readaptation would be completed. This would explain why a new journal and box would always heat on first being run, however perfect they might be.

Deaths by Poisoning.—According to the English Registrar-General's reports, deaths by poisoning occur with alarming frequency in the ordinary course of events. In 1881, 569 deaths were recorded in England alone from this cause; in 1882, 599, or one in every 863 of the total deaths registered. Fully two fifths of the cases in the latter year were classified under the heading "accident and negligence"; the rest, 288, were suicides. Of the deaths through accident or negligence, 85 were occasioned by opium, laudanum, and morphia; 78 by lead compounds; 34 by the four stronger acids—hydrochloric, nitric, sulphuric, and carbolic; 14 by chloral; 11 by phosphorus; nine by arsenic; six by chlorodyne; four by chloroform; and four by soothing-sirup. How came the victims of these poisons to take them accidentally in fatal doses? The medical reports on the subject trace the mistakes to two principal causes—the giving or taking of overdoses of certain remedies containing poisons, and the substitution of one bottle or substance for another, as where bottles of all kinds of things are piled together in the cupboard, and, in the nervousness of haste or in carelessness, the wrong one is taken. The remedies for these dangers ought to be obvious. One is, never to give an infant an opiate or other powerful soothing remedy without first obtaining the sanction of a doctor. Another is, that no patient taking powerful remedies should be permitted, or should permit himself, to measure or repeat the dose himself. A third is, never to place bottles or packets containing poison alongside of or near anything that is to be taken internally. Fourth, never to put any poison into bottles, jugs, or cups which children or any other persons are apt to associate in their minds with substances not in themselves dangerous. The last remedy is sovereign. It is, not to keep strong remedies on hand.

Relation of Color and Flavor in Fruits and Vegetables.—Mr. Emmett S. Goff records in the "American Naturalist" some investigations he has made to determine whether there may not be a law of relation between the color and flavor in fruits and vegetables. He was led to his experiments by the observation that in several fruits and vegetables, such as onions, currants, tomatoes, and raspberries, a white or light-colored flesh is accompanied by a milder and more delicate flavor than exists in other varieties of the same fruit or vegetable having a dark-colored flesh; also that some vegetables are "blanched" to give them a more delicate flavor. The usual aim in improving the qualities of fruits and vegetables is to intensify the desirable qualities and eliminate the undesirable ones. It is evident, therefore, Mr. Goff says, that, if the color of the flesh has a direct relation to its flavor and tenderness, we have a valuable index in the work of selection. If by whitening the flesh of a fruit we can eliminate acid and solidity, or if by darkening the flesh of another fruit, already too tender and insipid, in the same way, we can heighten its characteristic flavor and increase its firmness, we have gained a new faculty in making the products of Nature subservient to our wants. Mr. Goff supports his view by the citation of a number of fruits and vegetables of peculiar qualities, and quotes descriptions by various authors, which appear to be in agreement with it.

The Harp-Seal in the St. Lawrence River.—It has been long known that the harp-seal (*Phoca Groenlandica*) was accustomed to visit the Gulf of St. Lawrence for bringing forth its young; but Dr. C. Hart Merriam has collected evidence that its existence in that river is far more general and fixed than had been supposed. Mr. Napoleon A. Comeau, who lives near the point

of the expansion of the river into the gulf, says that this species is the most abundant of all the seals of that locality, and roves up and down the St. Lawrence in its migrations in immense numbers; and he adds that it is tolerably common as far up as the Saguenay. From the information furnished by Mr. Comeau and from other data, it appears to Dr. Merriam that the harp-seal is a permanent resident in the St. Lawrence; that it spends the summer wandering about, sometimes singly or in small schools, sometimes in large herds; that it ascends the river at least as far as the Saguenay, and is common between Mille Vaches and Manicouagan; that it frequents with considerable regularity particular shores and estuaries to feed on the small fish that congregate there at certain states of the tide; that it works down the river early in the winter, and is particularly abundant about Point des Monts in December, January, and the early part of February; that it then passes farther down to whelp on the heavy ice in the gulf; that its young are born during the latter part of February or early March; that, as soon as the young are able to shift for themselves, the parents at once return, passing Point des Monts in great numbers on their way up the river.

Alleged Nerve-exciting Properties of American Air.—A correspondent of the London "Times" notices as a fact coming within his own personal experience the effect of the American air, particularly in New York, in exciting nervous sensibility. It is partly an effect of dryness, partly electrical, as is witnessed by the power sometimes observed of lighting a gas-jet with the electric spark developed by shuffling rapidly over the carpet. It is observed also in the greater intensity of the effect of spirituous liquors in this country than in Europe. It is partly local, for it is more marked in New York than in any other place. It seems to be evolving a new type of mind, and ultimately possibly a new physical type; and the American appears to be becoming a more nervous and more spirited man. Hence, we have peculiarities in our statistics of insanity; our army of tramps —"individuals of all classes, though mainly of the poorer, who can not endure the drive and strain necessary to keep up with their fellows, and whose inertia triumphs"—and our cranks—"people who carry eccentricity almost to insanity, but are recognized as responsible persons." After noticing an increasing development of insanity among our native-born population, the writer mentions two questions that suggest themselves: "Are we becoming a nation of madmen," or "are we developing a specialized race from those who can endure the pressure, and who by the survival of the fittest will form the future American stock, while the feeble intellectual natures will become tramps and lunatics?"

The Weather and Health.—Dr. J. W. Tripe read a paper at the Meteorological Conference, held in connection with the London Health Exhibition, on "The Relations of Meteorological Phenomena to Health." It is only recently that systematic observations have made the collation of knowledge on this subject possible. Ordinary variations of the barometer at ordinary elevations produce but little effect on health. At considerable elevations disagreeable feelings follow the diminished pressure. Nevertheless, consumptive and other invalids have experienced relief at mountain-stations; but this was because the reduced temperature, with the total change in the habits of life, more than compensated for the effects of the lessened pressure. In residences a sudden diminution of atmospheric pressure is likely to be attended with an escape of ground-air from the soil, and thereby to cause injury to health. Changes of temperature when rapid are liable to cause derangements in either direction; otherwise man can with precautions endure a range of about 200° Fahr. without serious injury. Hot climates, however, eventually, unless habits are carefully adjusted to them, sap the foundations of life among Europeans. The direct influence of rain on man is not very marked in temperate regions, except by giving moisture to the air by evaporation from the ground and from vegetable life, and by altering the level of ground-water. Considerable and sudden fluctuations in the level of the ground-water generally cause ill health, and if such water stands at less than five feet below the surface it is dangerous. Vary-

ing amounts of moisture in the air materially affect health and comfort. Moist air is a better conductor of heat than dry air, hence we feel more chill in thaws than during crisp, cold weather. Fogs are injurious, not only on account of the vapors they contain, but because the air is saturated with moisture at a low temperature. Variations in temperature and pressure exert a considerable influence on the circulation of air contained in the soil (ground-air), and this frequently contains that which it is not well to breathe. Winds affect health directly by promoting evaporation from the skin and abstracting heat from the body, and indirectly by their influence on the temperature and pressure of the air. Scarlet fever prevails most when the mean temperature is between 45° and 57° Fahr. Diseases of the lungs are fatal in proportion to the lowness of the temperature and the presence of excess of moisture and fog. Relations appear to exist between a high summer temperature and mortality from diarrhœa. The relations between the weather and disease are not always uniform, for a discordance has been observed in the curves for whooping-cough, typhoid fever, and scarlet fever, between London and New York, and in diarrhœa between London and India. Better information is needed on this subject.

Spectro-photometric Study of Pigments.—Edward L. Nichols, Ph. D., in a paper read at the last meeting of the American Association on "A Spectro-photometric Study of Pigments," finds that the spectroscope shows that pigments can not be considered even in the roughest approximation as reflecting monochromatic light, but that they are more nearly related to white. Hence, "the attempt to express the hue of non-luminous bodies by comparison with isolated spectral tints is founded upon a false conception of the nature of the light which they reflect. To determine the hue of a pigment from the analysis of the light it reflects is a problem in physiological optics, the solution of which varies with the character of the observer's eye. The three primary color-curves of the eye must be determined, and the total intensity of each wave-length of the spectrum of the pigment must be divided in the proportions indicated by the color-curves into three components—red, green, and violet. Summing up each of these components for the entire spectrum, we obtain an expression for the hue in terms of the three color-sensations of which it is the resultant. In default of this method, which is difficult of execution, the curves themselves are an expression of the hue, the only requisite for the interpretation of which is practice in associating the sensation of color produced by pigments with the form of curve representing them."

The Manufacture and Applications of Iridium.—The manufacture of articles from iridium has recently assumed considerable importance through the discovery of practicable methods for making the metal. Iridium is obtained, in Russia and California, as a by-product in the working of the ores of platinum and gold, and is found only in the condition of grains, not larger than grains of rice, or of a fine powder, and often alloyed with platinum or osmium. It is one of the hardest substances known, being in that respect nearly the peer of the ruby, is not readily or permanently acted upon by oxygen, and is soluble in no single acid, and only slightly soluble in *aqua regia*. Its principal use hitherto has been for the pointing of gold pens, for which purpose the grains had to be taken as they were found, and soldered on without working over. The discovery of the process for working iridium is due to two gentlemen of Cincinnati, Mr. John Holland, a gold-pen manufacturer, who found that it could be melted with phosphorus; and Mr. W. L. Dudley, who devised a method for afterward eliminating the phosphorus. Mr. Holland, seeking larger pieces of iridium than could be found in Nature, discovered, after many experiments, that by heating it to a white heat and adding phosphorus, with a few minutes more of heating, he could obtain a perfect fusion, and could pour out the molten metal and get a casting of it. The product proved nearly as hard as the natural grains of iridium, and to have nearly all the properties of the metal itself, but, containing from 7·52 to 7·74 per cent of phosphorus, was liable to fusion, and could not therefore be used for purposes, as in elec-

trical apparatus, where it would have to withstand a white heat. Mr. Dudley undertook the removal of the phosphorus, and found that this could be effected perfectly by heating the metal with lime in an electric furnace. The manufactured metal will then resist as much heat without fusion as the native metal. Iridium is sawed by a copper disk between four inches and eight inches in diameter, making twenty-five hundred revolutions a minute, and dipping into a bath of cotton-seed oil and corundum or diamond-dust. Many new uses are opening for it since it has been possible to melt and cast it. It is used for draw-plates, to replace the ruby plate, in the manufacture of gold and silver wire; for knife-edges for scales and balances; for tipping hypodermic needles; for the negative poles of arc-lamps; and for many other purposes. One of the most important applications is for the contact-points of telegraphic instruments. These points outlive many platinum contacts, and do not oxidize or stick. Mr. Dudley is making experiments, with a fair promise of reaching commercial success, in the electric deposition of iridium.

The Chaldean Lunar Cycle.—M. Oppert recently read a paper before the Academy of Inscriptions and Belles-Lettres on an Assyrian inscription concerning lunar cycles. More than twenty years ago he discovered in the inscriptions of King Sargon allusions to a great lunar cycle one of the revolutions of which terminated in the year B. C. 712. He was afterward convinced that this cycle was the period of 1805 years, after which the series of lunar eclipses recur in the same order. The knowledge of this period supposes continuous astronomical observations among the Chaldeans already of many centuries' duration. They began the calculation of the period from the year 11,542 before our era. This is also the year in which the Sothiac periods (of the Egyptians) of 1460 years begin, one of which ended B. C. 139. These two cycles of 1460 years and 1805 years play an important part in the chronological computations of the ancient East. Twelve of each of them form respectively 17,520 and 21,660 years, or 292 and 361 sixties of years, numbers which occur in the Bible, according to M. Oppert, to express the length of time between the Flood and the birth of Abraham, and from the birth of Abraham to the end of the history in Genesis.

NOTES.

THIRTY years ago pines were planted in the Sologne, a tract of waste land near Blois, France. Fifteen years afterward, as the pines were cut away, oaks sprang up spontaneously to take their places, thus tending to restore what history tells was the ancient vegetation of the country. M. Émile Hausen-Blangsted states, in illustration of the struggle for existence among trees, that the pine is dislodging the larch in the Grisons, while there and in the Jura the beech prevails over both. In Switzerland generally the beech gains the place of the oak, fir, and birch, and in Prussia the pine encroaches on the oak and the birch. Birches and the ash are extending themselves in the pine-forests of Russia, and the birch is dislodging the aboriginal pines in Siberia.

MR. FREDERICK RANSOME is making a cement from blast-furnace slag and lime, much superior to the cements previously made from this refuse matter. He uses lime from the gas-works, gets rid of the sulphur by calcination with coal or coke, and then dissipates it in the form of sulphureted hydrogen. While Portland cement breaks under a load of 818 pounds, this cement, under the same circumstances, exhibits a power of cohesion up to 1,170 pounds.

THE *Convallaria polygonatum*, whose name indicates its relation to the lilies-of-the-valley, may fairly be described as a traveling plant. It has a root formed of knots, by which it annually advances about an inch from the place where the plant was first rooted. Every year another knot is added, and this drags the plant farther on; so that in twenty years' time the plant will have traveled about twenty inches from its original place.

THE continued publication of the "Index Medicus" has been undertaken, after arrangement with the editors and the representatives of the late Mr. F. Leypoldt, the former publisher, by Mr. George S. Davis, of Detroit. The first number of the journal for the current year, having been necessarily delayed, will comprise the literature of January, February, and March. Further publication will be made monthly as usual. At the end of the year, in addition to the usual index of names, subscribers will be furnished with an index of subjects to the volume.

THE Geological Society has awarded the Wollaston medal to Mr. George Busk for his researches on fossil polyzoa and pleistocene mammalia; the Murchison medal to Professor Ferdinand Roemer, of Breslau; the Lyell medal to Professor H. G. Seeley, for his long-continued work on fossil saurians; and the Bigsby medal to M. Renard, of the Brussels Museum, for his petrographical researches.

THE "Saturday Review" gives some more illustrations of the learning that is fostered by the English School-Board cram examinations. One is, that "the earth's axis is a pole put through the center of the sun, which turns it round." Another pupil stated that "the Nile is the only remarkable river in the world. It was discovered by Dr. Livingstone, and rises in Mungo Park." On ancient Britain the examinations brought out statements that Julius Cæsar invaded the country B. C. 400; that the women "wore their hair down their backs, with torches in their hands"; and that the "Druids were an ancient people, supposed to be Roman Catholics."

THE latest reports from Sydney with reference to the *Monotremata* state that Mr. Caldwell has exhibited specimens "showing the stages in the development of the monotremes from the laying of the egg to the hatching," and that Baron Miklucho-Maclay, who had found that the temperature of *Echidna* was 82·5° Fahr., now finds that that of the Ornithorhyncus is only 76° Fahr., or more than 20° below that of man.

MESSRS. SCHULZ, KNAUDT & Co., Essen, Germany, are now producing, from the refuse of the fire-grates of the puddling and reheating furnaces, two hundred cubic metres of water-gas per hour, which contains forty-eight per cent of hydrogen, and forty-four per cent of carbonic oxide. The gas is used for welding and in the production of incandescent lights. The firm are about to build apparatus that will generate fourteen thousand cubic metres of the gas per day.

IN a recent paper by MM. Fremy and Urbain, before the French Academy of Sciences, attention is called to *cutose*, the substance that covers and protects the aërial organs of plants, which is shown to approach the fatty bodies in its properties and composition. It resists the action of energetic acids, is insoluble in dilute alkalies, and is not acted upon by neutral solvents, but is modified in its conditions by boiling alkaline liquids.

IN a recent paper before the Royal Society on "Underground Temperatures," Professor Prestwich, after considering the sources of error that affect thermometric observations in collieries and mines, suggested, as the result of a large number of observations in mines, Artesian-well borings, and Alpine-railway tunnels, that the mean thermic gradient is about forty-five feet for every degree Fahrenheit.

OBITUARY NOTES.

GENERAL HELMERSEN, a Russian officer of considerable distinction as a geologist and explorer, is dead.

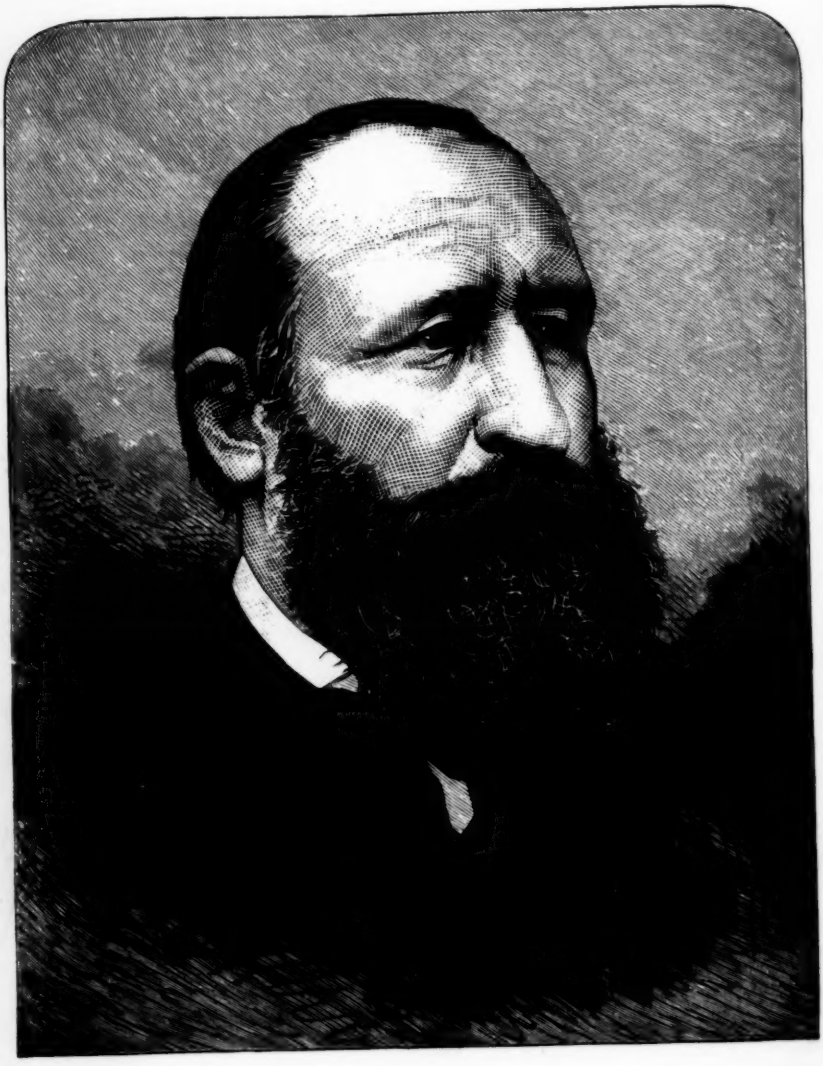
THE death is announced of Hofrath Schmid, Professor of Mineralogy at Jena.

MR. JOHN FRANCIS CAMPBELL, who recently died in England, was the inventor of a "sunshine recorder," a curious instrument in which the sun burned out its path for every hour of the day when visible, and indicated by the amount of charring the ever-varying intensity of the influence of its rays. Other instruments have been invented with similar purpose, but their power is generally limited to the registration of the chemical action of the sun's rays.

MR. HODDER M. WESTROPP, archæologist, author of a "Manual of Archæology" and other works, is dead.

MR. THOMAS C. ARCHER, Director of the Edinburgh Museum of Science and Art, died February 19th. While a customs clerk in Liverpool, he was appointed to take charge of the exhibit of that town in the Great Exhibition of 1851. He afterward added to his usual duties the work of lecturing at local institutions and educational establishments, and became a professor in the Liverpool Institution. He was appointed to the Museum in Edinburgh in 1860. Among his scientific publications are a text-book on "Economic Botany," and papers before the Royal Society of Edinburgh on "Graphite in Siberia," on an undescribed variety of flexible sandstone, on "Two Species of Foraminifera," and on "some objects from the Nicobar Islands of great ethnological interest."

MR. SIDNEY GILCHRIST THOMAS, whose name is inseparably associated with the basic or Thomas-Gilchrist process for making steel from phosphoric pig-iron, died in Paris on the 1st of February. He was educated at Dulwich College, England, and was intended for the medical profession, but entered the civil service, while he kept up all his life a strong interest in the study of chemistry. The first announcement of the discovery in iron-working which he and his relative, Mr. Gilchrist, had made, was given in a paper which he read before the Iron and Steel Institute in 1878, "On the Elimination of Phosphorus."



ALFRED E. BREHM.